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SECOND AMERICAN EDITION.

OF

Nicholson's

BRITISH ENCYCLOPEDIA

or Dictionary of

ARTS & SCIENCES

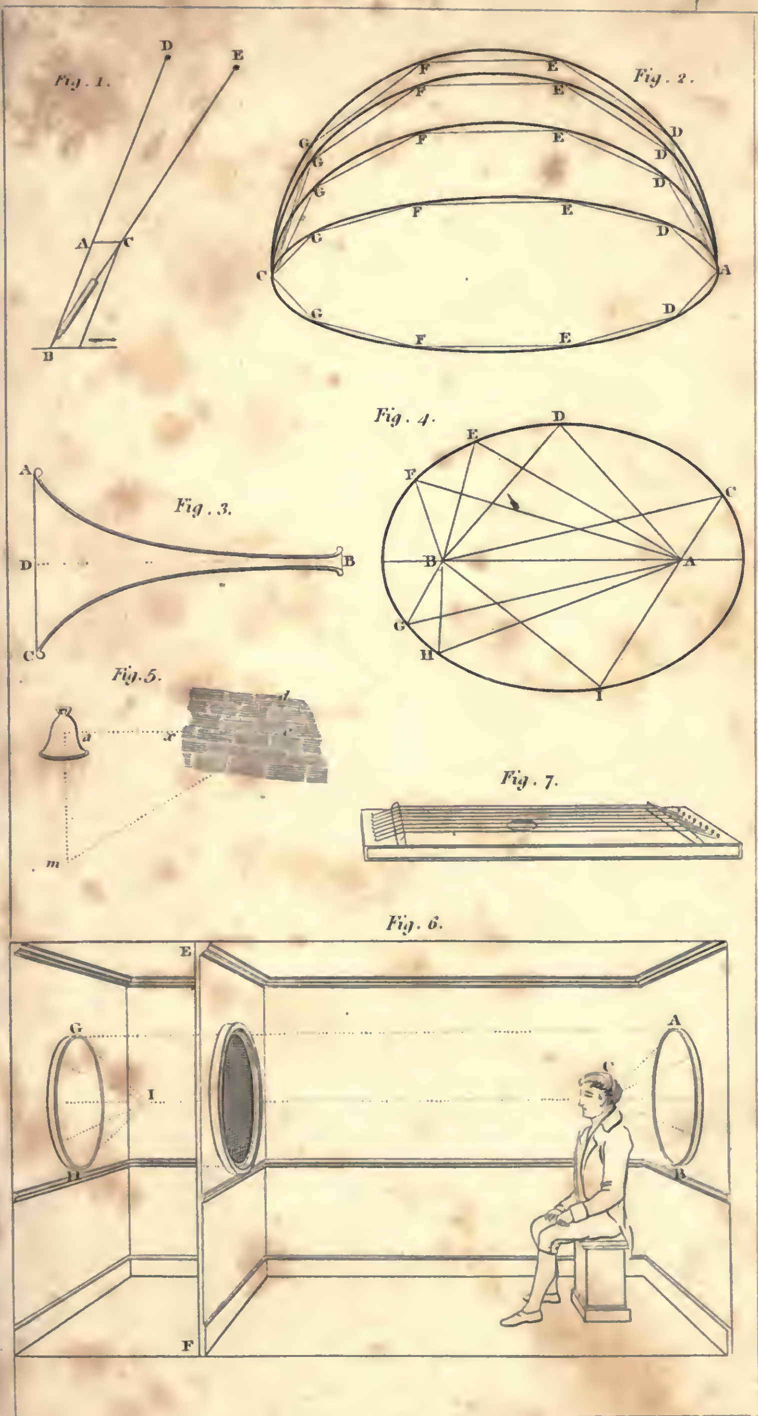
illustrated by upwards of 180 elegant Engravings.

PHILADELPHIA

Published by Mitchell, Ames & White.

W. Brown Printer.

1818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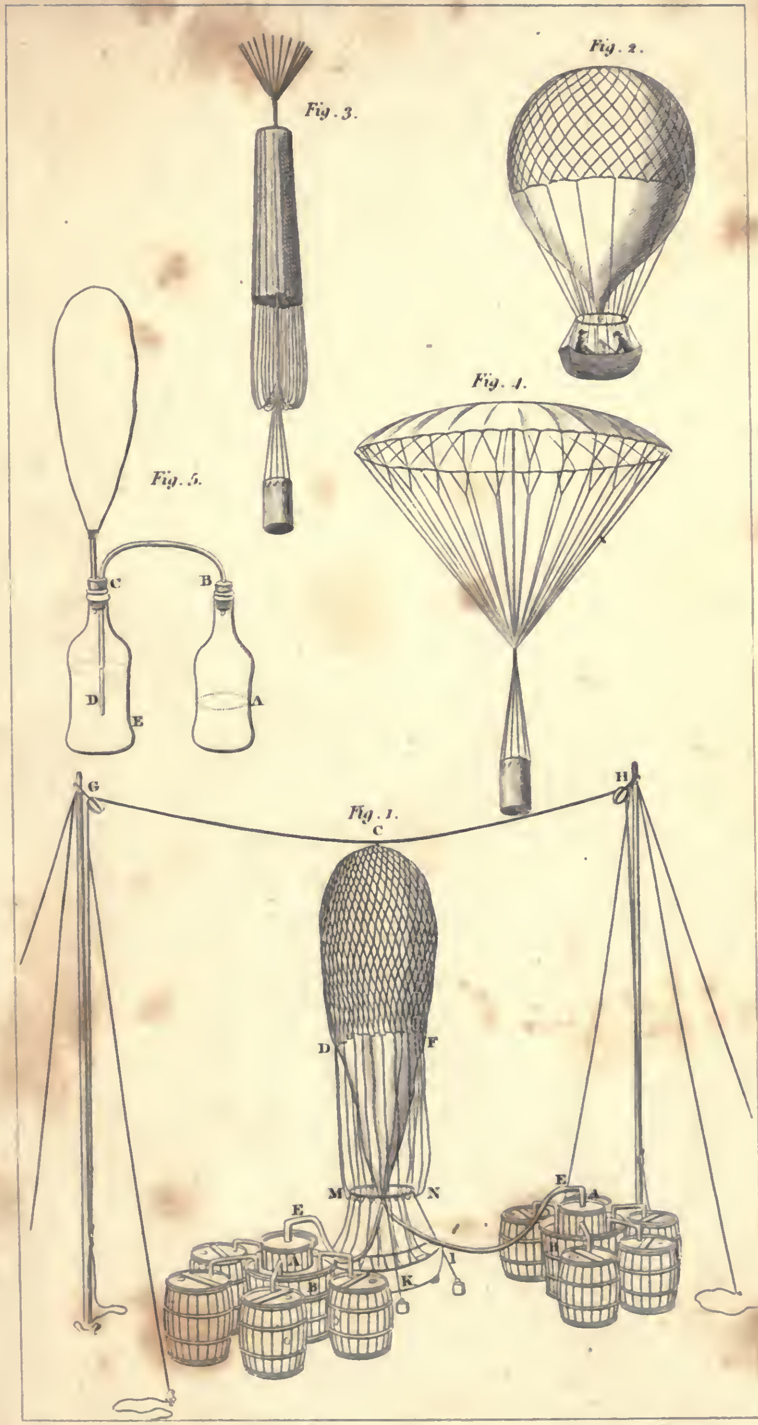
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Fig. 1.

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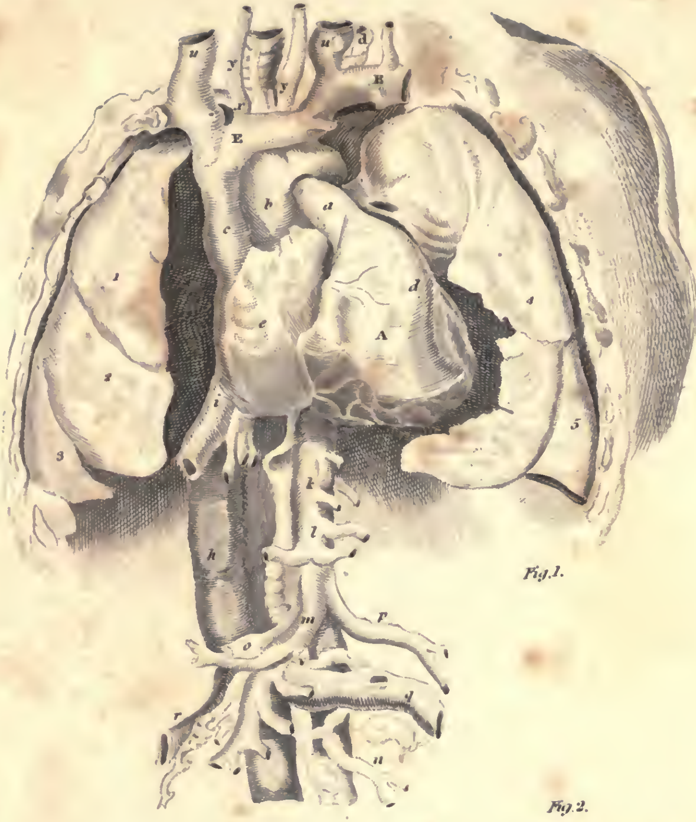

Fig. 1.

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Kneass, Young, &c.

Fig. 1. Antelope strepsiceros; striped antelope Fig. 2. A. Oryx. Indian Antelope Fig. 3. White Antelope.
Fig. 4. A. Gnu Fig. 5. Chevrotain Fig. 6. Meminna.

Tuscan Order. — from Palladio. Pl. I.

Strickland del.t Knauss Sc.

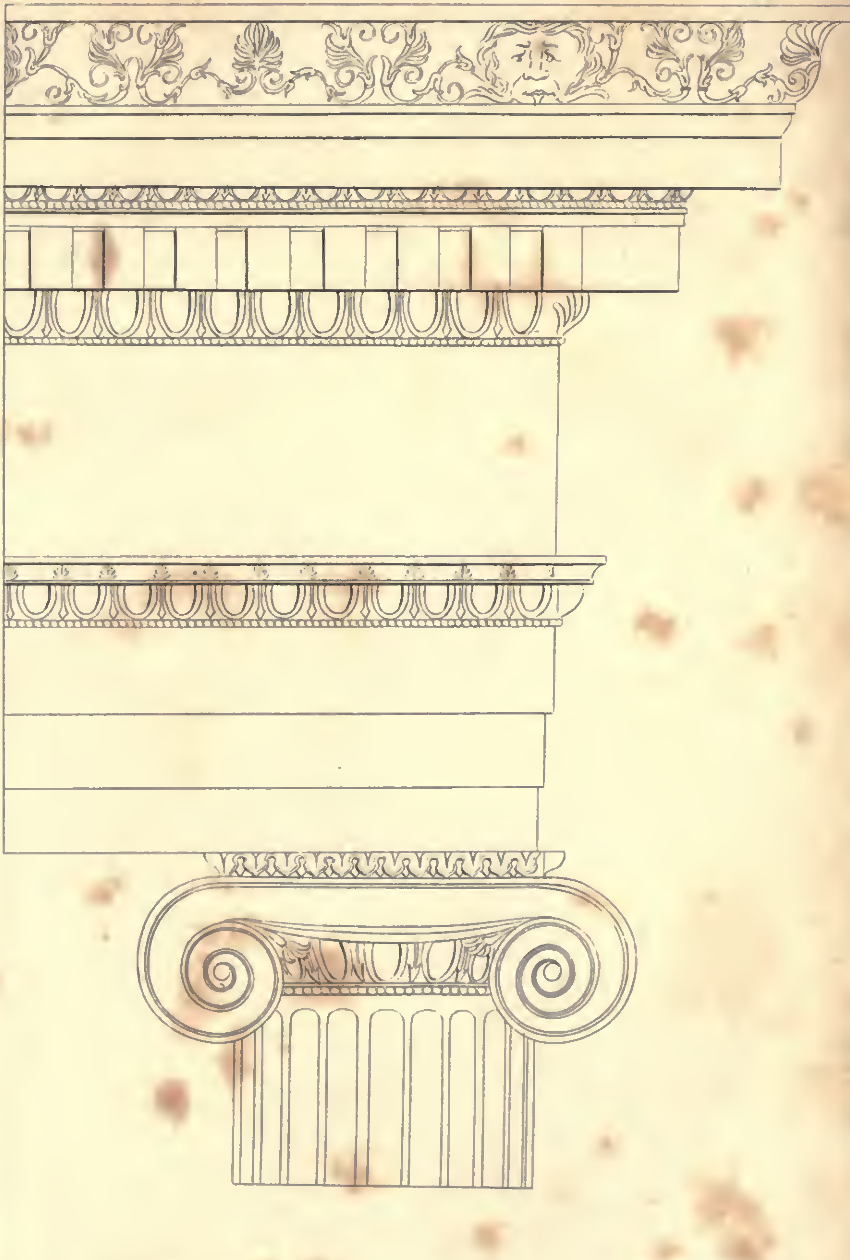
From the Temple of Minerva Parthenon at Athens.

Pl. II.

Strickland Arch.t Kneass Sc.

From the Temple of Bacchus at Teos

Pl. III.



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From the Temple of Jupiter Stator at Rome

From the Arch of Titus at Rome Pl. X.

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AMERICAN EDITION

OF THE

BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

OF

ARTS AND SCIENCES.

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 180 ELEGANT ENGRAVINGS.

VOL. I. A.....ARE.

PHILADELPHIA:

PUBLISHED BY MITCHELL, AMES, AND WHITE.

W. Brown, Printer, Prune Street.

1818.

PREFACE.

THE experience of more than a century has eminently proved the advantages of such works as exhibit, under an alphabetical arrangement, the complete circle of human knowledge. Dictionaries of language, of general terms, and of particular branches of science and art, have been multiplied by the labours of men fully qualified to display the subjects they have undertaken to discuss; and the first characters in the various nations of Europe have been proud to rank their names and unite their exertions in the production of immense works, containing every subject which can engage the intellectual research or active occupation of man. The order of the alphabet has been so skilfully combined with that order which is indicated by the natural relations of the materials, that works of this description have been received with the most striking approbation; and, notwithstanding the great labour and expense required to keep pace with the rapid improvements and discoveries of modern times, the number of Dictionaries of all descriptions have been so great, that it would be difficult, and perhaps useless, even to name them, and point out their respective merits.

From the great Encyclopedias, each of which may be said to constitute an entire library, to those smaller compositions intended for mere reference:—from the hurried compilations of book-makers to those elaborate and luminous works in which men of the highest reputation

have recorded their comprehensive views, and their most striking discoveries, it is not difficult to observe and deduce the distinct and separate utilities of each, and the duties to be expected from the editors and proprietors of such undertakings. Among the most obvious of these it is indispensable that a new work should be called for, by circumstances which point out advantages of size, plan, and materials, not before adopted, and that the means to be employed, in the actual performance, should be such as must determine its worth and authority with every description of readers.

We are already in possession of the large Cyclopedia of Dr. Rees, which has advanced to its twelfth volume, by a progress that insures its regular completion, and in a style of execution which is truly honourable to the skill and diligence of those who have undertaken it; to the activity and enterprize of the proprietors, and to a nation which has ever taken the lead in science and the arts. On the smaller Dictionaries it is needless to enlarge. After various deliberate consultations between the Proprietors, the Editor, and the principal gentlemen engaged in the different departments, it was concluded, that *a new Dictionary, appropriated exclusively to the Arts and Sciences, and containing a dense, accurate, and ample exhibition of our whole knowledge respecting them, might with the greatest advantage be comprehended in the limits of six large octavo volumes.* It was accordingly decided, that the undertaking should be entered upon with vigour and activity, at the same time that the utmost attention should be paid to the means by which alone it was possible to insure the value of the intended work. The year preceding its appear-

ance was employed in digesting the plan, establishing correspondences, investigating the various sources of information, and settling the order and disposition of the materials; and it was not until after those materials were in considerable forwardness, and the whole arrangement was before the Editor, that the Proprietors thought themselves enabled to disclose their views, and express their confidence in the public support.

If the value of a composition of the magnitude and extent of the British Encyclopedia could be seen at once by a cursory or even by a diligent examination; or if the variety of subjects it comprehends would admit of the supposition, that a decision on its merits could be made, in a reasonable time, by general readers, it might then be consistent with the becoming reserve of men, speaking of their own labours, to submit them wholly to the ultimate voice of a discerning public. But when, by compilation from the works of authors, standing high in celebrity for knowledge and for talents; by the occasional abridgment and elucidation of the products of these researches; and by the insertion, in almost every sheet, of treatises or disquisitions composed expressly for the purpose, the whole composition of a Dictionary of Science shall bear the marks of originality, it becomes a duty in the Editor, with regard to himself and the other writers, that he should, to a certain extent, point out what has been done in this respect.

It would be truly gratifying to the Editor if he might attempt in this place to express his sentiments of the treatises which have passed under his view in the conduct and disposition of the present work, and declare his obligations individually to each of the writers who

have honoured him with their assistance in the completion of the undertaking; but he fears that the language of approbation which he would in justice feel himself compelled to use, might be misconstrued into an unbecoming endeavour to enhance, beyond its merits, the value of the publication. Some of the authors of the British Encyclopedia have chosen to reserve their names. The Editor has written and composed upwards of two hundred articles on Chemistry, Natural Philosophy, and Mechanics, and practical subjects relating to them, besides several of the lives of great men. The Mathematical Articles, including the mixed subjects of Astronomy, Optics, Phonics, Statics, and many others, were drawn up by a popular author, who is well known for his writings on those subjects. The article Conic Sections was written by JAMES IVORY, Esq. of the Royal Military College of Marlow. To the Rev. Dr. CARPENTER, of Exeter, our readers are indebted for the articles Grammar, Language, Mental and Moral Philosophy, Understanding, the Origin of Writing, and many others connected with the philosophy of the mind. For the articles Criticism, History, Poetry, and Rhetoric, our obligations are due to the Rev. WM. SHEPHERD, author of the life of Poggio Bracciolini. To J. J. GRELLIER, Esq. of the Royal Exchange Insurance Company, are to be ascribed many valuable articles on Political Economy, the Doctrine of Annuities, Reversions, Assurance, &c.

In our Medical Department, the articles Dietetics, Diseases and Treatment of Infancy, Materia Medica, Medicine, Midwifery, and Pharmacy, were written by J. M. GOOD, Esq. the learned translator of "Lucretius,"

and author of many works in medicine, and the sciences connected with it. Those on Anatomy, Comparative Anatomy, the Natural History of Man, Physiology, Surgery, &c. were drawn up by W. Lawrence, Esq. of St. Bartholomew's Hospital.

To a very ingenious pupil of Dr. Smith, the celebrated President of the Linnean Society, we are indebted for the introductory treatise on Botany. Dynamics, Hydraulics, Music, Fortification, Perspective, and many other articles in Mathematics and Experimental Philosophy; and also those on Farriery and Gardening, were composed by Capt. Williamson, a gentleman well known to the literary and philosophical world. The articles Distillery and Galvanism were written by Mr. Sylvester of Derby, whose discoveries in the latter new and promising department of experimental research are well known to philosophers. To W. Y. Ottley, Esq. we acknowledge ourselves indebted for the article Painting. And to Mr. J. P. Malcolm, author of "The Antiquities of London," are to be ascribed those on Heraldry, Topography, and other articles connected with the Arts.

James Parkinson, Esq. author of an elaborate and extensive work on the "Organic Remains of a former World," composed the articles Geology, Oryctology, Rocks, and Shells, which appear in this Dictionary. Those on Dyeing, and on the Manufacture of Cotton, deduced from actual observation, with several others relating to practical Mechanics, and subjects of a mixed nature, were furnished by W. Boswell, Esq.; and those on Weaving and Short-hand by Mr. Nightingale. Mr. Peter Nicholson is the author of the

treatises on Architecture and Building; and the processes of particular Arts and Manufactures were either communicated by professional men, or in various instances drawn up under their inspection.

When the reader shall have directed his attention to the ample quantity of original and excellent matter contained in the articles here pointed out, besides others more concise, and interspersed through the work, he will be enabled to form some judgment of its utility and comparative cheapness.

It is now a year since the Proprietors and Conductors of this work solicited the public encouragement, with a full determination to spare no exertions in performing the duties required in their arduous undertaking. The event, they trust, has gratified their expectation. The British Encyclopedia was commenced, has been regularly continued, and is now completed in six handsome volumes, agreeably to the Prospectus. In the typographical execution of this Dictionary, and in the engravings with which it is illustrated, they feel confident they may claim a superiority over every other work of the same kind. An extensive sale has already given proof of the approbation they have laboured to deserve; and they trust, that as the British Encyclopedia continues to increase in circulation, it will maintain the reputation it has already acquired.

BRITISH ENCYCLOPEDIA.

A. The first letter of the alphabet, and one of the five vowels, is pronounced variously; sometimes open, as in the words *talk*, *walk*; and at others close, as in *take*, *wake*.

A is also used, on many occasions, as a character, mark, or abbreviation. Thus, in the calendar, it is the first of the dominical letters; among logicians, it denotes an universal affirmative proposition; as a numeral, A signified 1 among the Greeks; but among the Romans, it denoted 500, and with a dash over it, thus $\bar{A}$, 5000. A, $\bar{a}$, or $\overline{aa}$, among physicians, denote ana, or an equal weight, or quantity, of several ingredients.

AAM, or Haam, a liquid measure used by the Dutch, equal to 288 pints English measure.

ABACK, in sea language, signifies the situation of the sails when their surfaces are flatted against the mast. They may be brought aback, either by a sudden change of wind, or an alteration in the ship's course. They are laid aback, to effect an immediate retreat, without turning either to the right or left, to avoid some immediate danger in a narrow channel, or when she has advanced beyond her station in the line of battle.

ABACUS, in architecture, the uppermost member of the capital of a column. In the Greek Doric, it is a plane square fillet. In the Ionic, and Corinthian, moulded and enriched.

Abacus, among ancient mathematicians, was a table strewed over with dust, or sand, on which they drew their figures or schemes.

Abacus, in arithmetic, an instrument for facilitating operations by means of counters. Its form is various; but that chiefly used in Europe is made by drawing parallel lines, distant from each other at least twice the diameter of a counter; which, placed on the lowermost line, signifies 1; on the second, 10; on the third, 100; on the fourth, 1000; and so on. Again, a counter, placed in the spaces between the lines, signifies only the half of what it would do on the next superior line.

Abacus, *pythagoricus*, a multiplication-table, or a table of numbers ready cast up, to facilitate operations in Arithmetic.

Abacus, *logisticus*, is also a kind of multiplication-table, in form of a right-angled triangle.

Abacus, *harmonicus*, among musicians, denotes the arrangement of the keys of a musical instrument.

Abacus, *Grecian*, an oblong frame, over which are stretched several brass wires, strung with little ivory balls, by the various arrangements of which all kinds of computations are easily made.

Abacus, *Chinese*, or Schwanpan, consists of several series of beads strung on brass wires, stretched from the top to the bottom of the instrument, and divided in the middle by a cross piece from side to side. In the upper space every string has two beads, which are each counted for five; and in the lowest space every string has five beads, of different values, the first being counted as 1, the second as 10, the third as 100, and so on.

ABAFT, in sea-language, a term applied to any thing situated towards the stern of a vessel: thus a thing is said to be abaft the fore-mast, or main-mast, when placed between the fore-mast, or main-mast, and the stern.

Abaft *the beam*, denotes the relative situation of any object with the ship, when the object is placed in any part of that

arch of the horizon, which is contained between a line at right angles with the keel and that point of the compass which is directly opposite the ship's course.

ABAS, a weight used in Persia for weighing pearls, being one eighth part lighter than the European carat.

ABASED, in heraldry, is said of the wings of eagles, &c. when the tip looks downwards to the point of the shield, or when the wings are shut; the natural way of bearing them being spread.

ABATE, in law, signifies to break down or destroy, as to abate a nuisance, and to abate a castle. It means to defeat and overthrow, on account of some error or exception.

ABATEMENT, in heraldry, something added to a coat of arms, in order to lessen its true dignity, and point out some imperfection or stain in the character of the person who bears it.

Abatement, in law, signifies the rejecting a suit, on account of some fault either in the matter or proceeding. Hence, plea in abatement is some exception alleged, and proved, against the plaintiff's writ, declaration, &c. and praying that the plaint may abate or cease; which being granted, all writs in the process must begin *de novo.*

ABATOR, in law, one who enters into a house or lands, void by the death of the last possessor, before the true heir; and therefore keeps him out, till he brings the writ *intrusione.*

ABDOMEN, in anatomy, the lower part of the trunk of the body, reaching from the thorax to the bottom of the pelvis. See Anatomy.

ABDOMINALES, in natural history, an order of fishes, having ventral fins placed behind the pectoral in the abdomen, and the branchia ossiculated. This order comprehends sixteen genera, viz.

Amia	Cobitis	Atherina
Clupea	Esox	Cyprinus
Elops	Loricaria	Exocoetus
Fistularia	Salmo	Mugil
Polynemas	Teuthis	Silurus
Argentina		

ABDUCTOR, or Abducent, in anatomy, a name given to several muscles, on account of their serving to withdraw, open, or pull back the parts to which they are affixed. See Anatomy.

ABERRATION, in astronomy, an apparent motion of the heavenly bodies, produced by the progressive motion of light and the earth's annual motion in her orbit. Since light proceeds always in right lines, when its motion is perfectly undisturbed, if a fine tube were placed so as to receive a ray of light passing exactly through its axis when at rest, and then, remaining in the same direction, were moved transversely with great velocity, it is evident that the side of the tube would strike against the ray of light in its passage, and that, in order to retain it in the axis, the tube must be inclined, in the same manner as if the light, instead of coming in its actual direction, had also a transverse motion, in a direction contrary to that of the tube. The axis of a telescope, or even of the eye, may be considered as resembling such a tube, the passage of the light through the refracting substances not altering the necessary inclination of the axis. In various parts of the earth's orbit, the aberration of any one star must be different in quantity and in direction; it never exceeds 20″ each way, and therefore insensible in common observations. If AB and AC (Plate Acoustics, &c. fig. 1,) represent the comparative velocity of light and of the earth, in their respective directions, a telescope must be placed in the direction BC in order to see the star D, and the star will appear at E. This discovery was made by Dr. Bradley, in his observations to determine the annual parallax of the fixed stars, or that which arises from the motion of the earth in its orbit round the sun.

Aberration *of the planets*, is equal to the geocentric motion of the planet, the space which it appears to move, as seen from the earth, during the time that light employs in passing from the planet to the earth. Thus, with regard to the sun, the aberration in longitude is constantly 20″, which is the space moved by the earth in the time 8′ 7″, which is the time that light takes to pass from the sun to the earth. Hence, the distance of the planet from the earth being known, it will be, as the distance of the sun is to the distance of the planet, so is 8′ 7″ to the time of light passing from the planet to the earth; then computing the planet's geocentric motion in this time, will give the aberration of the planet, whether it be in longitude, latitude, right ascension, or declination. The aberration will be greatest in longitude, and but very small in latitude, because the planets deviate very little from the plane of the ecliptic. In Mercury it is only $4\frac{1}{3}''$ and much less in the other planets. The aberration in declination and right ascension depends on the situation of the planet in the zodiac. The aberration in longitude, being equal to the geocentric motion, will be more or less, according as

that motion may be. It will be least when the planet is stationary; and greatest in the superior planets, when they are in opposition; but in the inferior planets, the aberration is greatest at the time of their superior conjunction.

ABERRATION, in optics, a deviation of the rays of light, when reflected, whereby they are prevented from meeting in the same point. Aberrations are of two kinds; one arising from the figure of the reflecting body, the other from the different refrangibility of the rays themselves: this last is called the Newtonian aberration, from the name of the discoverer.

ABETTOR, or ABBETTOR, in law, the person who promotes or procures a crime to be committed: thus, an abettor of murder is one who commands or counsels another to commit it. An abettor, according as he is present or absent at the time of committing the fact, is punishable as a principal or accessary. See ACCESSARY.

An abettor is the same with one who is deemed *art and part*, by the law of Scotland.

ABEYANCE, in law, is that which is in expectation, remembrance, and intendment of law. By a principle of law, in every land there is a fee simple in somebody, or it is in abeyance; that is, though at present it be in no man, yet it is in expectancy, belonging to him that is next to enjoy the land. Where no person is seen or known, in whom the inheritance can vest, it may be in abeyance, as in limitation to several persons, and the survivor, and the heirs of such survivor, because it is uncertain who will be the survivor, yet the freehold cannot, because there must be a tenant to the præcipe always.

ABJURATION, in law, is used for renouncing, disclaiming, and denying the Pretender to have any manner of right to the throne of these kingdoms: and that upon oath, which is required to be taken upon divers pains and penalties by many statutes, particularly 1 W. and M. 13 W. III. 1 Anne, 1 Geo. I.

ABOLITION, in law, denotes the repealing any law or statute, and prohibiting some custom, ceremony, &c. Sometimes also it signifies leave granted by the king, or a judge, to a criminal accuser, to forbear any farther prosecution.

Abolition is also used by ancient civilians and lawyers, for desisting from, or annulling, a legal prosecution; for remitting the punishment of a crime; and for cancelling or discharging a public debt.

ABOMASUS, ABOMASUM, or ABOMASIUS, in comparative anatomy, names used for the fourth stomach of ruminating beasts, or such as chew the cud. These have four stomachs, the first of which is called *venter*; the second, *reticulum*; the third, *omasus*; and the fourth, *abomasus*. This last is the place where the chyle is formed, and from which the food descends immediately into the intestines.

ABORTION, in medicine, an untimely or premature birth of a fœtus, otherwise called a miscarriage; but if this happen before the second month of pregnancy, it is only called a false conception. See MEDICINE, MIDWIFERY, &c.

ABORTION, in law, if caused by giving a potion to, or striking, a pregnant woman, was murder, but now is said to be a great misprision only, and not murder, unless the child be born alive, and die thereof.

ABOUT, in military affairs, a word to express the movement, by which a body of troops changes its front, by facing according to any given word of command.

ABRA, a silver coin of Poland, nearly equivalent to the English shilling. See COIN.

ABREAST, a sea term, expressing the situation of two or more ships, that lie with their sides parallel to each other, and their heads advanced. When the line of battle at sea is formed *abreast*, the whole squadron advances uniformly. *Abreast within the ship*, denotes on a line with the beam, or by the side of any object aboard.

ABRIDGEMENT, in law, the shortening a count, or declaration: thus, in assize, a man is said to abridge his plaint, and a woman her demand in action of dower, if any land is put therein, which is not in the tenure of the defendant; for, on a plea of non-tenure, in abatement of the writ, the plaintiff may leave out those lands, and pray that the tenant may answer to the remainder. The reason is, that these writs run in general, and therefore shall be good for the rest.

ABROMA, in botany, a word signifying *not fit for food*, is used in opposition to Theobroma, as a genus of plants belonging to the natural order of Columniferæ, and the eighteenth class of Polyadelphia Dodecandria. There are two species, viz. the maple-leaved abroma, which is a tree with a straight trunk, yielding a gum when cut, and filled with a white pith like the elder; it flowers from June to October, and its fruit ripens in September and October; it is a native of New South Wales and the Philippine islands, was introduced into Kew gardens about 1770, and is a hot-house plant, requiring great heat, and much water:—and Wheler's Abroma, so

called by Koenig, in compliment to Edward Wheler, Esq. of the Supreme Council in Bengal; this is a shrub with a brown bark, a native of the East Indies, and is not known in Europe. There is but one of the species known in Europe, which is propagated with us by cuttings. The plant requires a strong heat, and abundance of water. The seeds rarely arrive at a state fit for propagation.

ABRUS, in botany, from a Greek word signifying soft or delicate, so called from the extreme tenderness of the leaves, is a genus of the natural order of Leguminosæ, and the seventeenth class of Diadelphia Decandria. There is one species, viz. the Abrus precatorius. It grows naturally in both Indies, Guinea, and Egypt. It is a perennial plant, rising to the height of eight or ten feet. Its leaflets have the taste of liquorice, whence it is called, in the West Indies, *Jamaica wild liquorice*, and used for the same purpose. There are two varieties, one with a white, and the other with a yellow seed. The seeds are commonly strung, and worn as ornaments in the countries where the plant grows wild; and they are frequently brought to Europe from Guinea, and the East and West Indies, and wrought into various forms with other hard seeds and shells. They are also used for weighing precious commodities, and strung as beads for rosaries, whence the epithet precatorius. They are frequently thrown, with other West India seeds, on the coast of Scotland. This plant was cultivated by Bishop Compton, at Fulham, before 1680. It is propagated by seeds, sown on a good hot-bed in spring, and previously soaked for twelve or fourteen hours in water. When the plants are two inches, each of them should be transplanted into a separate pot of light earth, and plunged into hot-beds of tanner's bark, and shaded from the sun. They will flower the second year, and sometimes ripen their seeds in England.

ABSCESS, in medicine and surgery, an inflammatory tumour, containing purulent matter. See SURGERY.

ABSCISSE, in conic sections, the part of the diameter of a curve line intercepted between the vertex of that diameter and the point where any ordinate, or semi-ordinate, to that diameter falls. From this definition it is evident, that there are an infinite number of variable abscisses in the same curve, as well as an infinite number of ordinates.

In the parabola, one ordinate has but one abscisse; in an ellipsis, it has two; in an hyperbola, consisting of two parts, it has also two; and in curves of the second and third order, it may have three and four. See CONIC SECTIONS.

ABSCISSION, in rhetoric, a figure of speech, whereby the speaker stops short in the middle of his discourse: e. g. one of her age and beauty, to be seen alone, at such an hour, with a man of his character. I need say no more.

ABSINTHIUM. See ARTEMISIA.

ABSORBENTS, in the materia medica, such medicines as have the power of drying up redundant humours, whether applied to ulcers, or taken inwardly. See MATERIA MEDICA and PHARMACY.

ABSORBENT *vessels*, in anatomy, are those which take up any fluid from the surface of the body, or of any cavity in it, and carry it into the blood. They are denominated according to the liquids which they convey, as *Lacteals*, or *Lymphatics*, the former conveying chyle, a milky fluid, from the intestines; the latter a lymph, a thin pellucid liquor, from the places whence they take their origin. The lymphatics also take up any fluids that are extravasated, and likewise substances rubbed on the skin, as mercury, and convey them into the circulation.

ABSTRACT *idea*, among logicians, the idea of some general quality or property, considered simply in itself, without any respect to a particular subject: thus, magnitude, equity, &c. are abstract ideas, when we consider them as detached from any particular body or person. Various controversies have been maintained respecting the existence of abstract ideas; but all these disputes seem to be merely verbal. It is certainly impossible to possess an idea of an animal, which shall have no precise colour, figure, magnitude, or the like; but it is an useful artifice of the understanding, to leave these out in our general reasonings. Thus it is that the *a, b, c*, &c. of the algebraists are usefully applied to denote numbers, though undoubtedly they are only general signs.

ABUCCO, ABOCCO, or ABOCCHI, a weight used in the kingdom of Pegu.

ABUNDANT *numbers*, those whose parts added together make more than the whole number: thus, the aliquot parts of 20, viz. 1, 2, 4, 5, 10, make 22.

ACACIA, in botany, a species of mimosa. See MIMOSA.

ACACIA, in the materia medica of the ancients, a gum made from the Egyptian acacia-tree, and thought to be the same with our gum-arabic.

ACADEMICS, a sect of philosophers,

who followed the doctrine of Socrates and Plato, as to the uncertainty of knowledge, and the incomprehensibility of truth.

Academic, in this sense, amounts to much the same with Platonist; the difference between them being only in point of time. They who embraced the system of Plato, among the ancients, were called Academici; whereas those who have done the same, since the restoration of learning, have assumed the denomination of Platonists. We usually reckon three sects of Academics; though some make five. The ancient Academy was that which was founded by Plato; and consisted of those followers of this eminent philosopher, who taught the doctrine of their master without mixture or corruption. The first of these was Speusippus; he was succeeded by Xenocrates. After his death the direction of the academy devolved upon Polemo, and then upon Crates, and terminated with Crantor. After the death of Crates, a new tribe of philosophers arose, who, on account of certain innovations in their manner of philosophising, which in some measure receded from the Platonic system, without entirely deserting it, have been distinguished by the appellation of the Second, or Middle Academy. The first preceptor who appears in this class, and who, in consequence of the innovations which he introduced into the Platonic school, has been commonly considered as the founder of this academy, is Arcesilaus. Before the time of Arcesilaus, it was never denied, that useful opinions may be deduced from the senses. Two sects arose about this time, which threatened the destruction of the Platonic system; one was founded by Pyrrho, which held the doctrine of universal scepticism, and the other by Zeno, which maintained the certainty of human knowledge, and taught with great confidence a doctrine essentially different from that of Plato. In this situation, Arcesilaus thought it necessary to exercise a cautious reserve with regard to the doctrine of his master, and to conceal his opinions from the vulgar, under the appearance of doubt and uncertainty. Professing to derive his doctrine concerning the uncertainty of knowledge from Socrates, Plato, and other philosophers, he maintained, that though there is a real certainty in the nature of things, every thing is uncertain to the human understanding, and consequently that all confident assertions are unreasonable. He thought it disgraceful to assent to any proposition, the truth of which is not fully established, and maintained, that in all questions, opposite opinions may be supported by arguments of equal weight. He disputed against the testimony of the senses, and the authority of reason; acknowledging, at the same time, that they furnish probable opinions sufficient for the conduct of life. However, his secret design seems to have been to establish the doctrine of Plato, that the knowledge derived from sensible objects is uncertain, and that the only true science is that which is employed upon the immutable objects of intelligence, or ideas.

After the death of Arcesilaus, the Platonic school was successively under the care of Lacydes, who is said to have founded a new school, merely because he changed the place of instruction, and held it in the garden of Attalus, within the limits of the Academic grove, and of Evander and Egesinus. Arcesilaus, however, had opposed the Stoics, and other dogmatical philosophers, with such violence, and extended his doctrine of uncertainty so far, as to alarm not only the general body of philosophers, who treated him as a common enemy to philosophy, but even the governors of the state, who apprehended that his opinions would dissolve all the bonds of social virtue and of religion. His successors, therefore, found it difficult to support the credit of the academy; and Carneades, one of the disciples of this school, relinquished, at least in words, some of the more obnoxious tenets of Arcesilaus.

From this period the Platonic school assumed the appellation of the New Academy, which may be reckoned the third in order from its first establishment. It was the doctrine of this academy, that the senses, the understanding, and the imagination, frequently deceive us, and therefore cannot be infallible judges of truth; but that, from the impressions produced on the mind, by means of the senses, called by Carneades phantasies, or images, we infer appearances of truth, or probabilities. These images do not always correspond to the real nature of things, and there is no infallible method of determining when they are true or false; and consequently they afford no certain criterion of truth. But, with respect to the conduct of life, and the pursuit of happiness, probable appearances are a sufficient guide, because it is unreasonable not to allow some degree of credit to those witnesses who commonly give a true report.

ACADEMY, in Grecian antiquity, a large villa in one of the suburbs of Athens, where the sect of philosophers called Aca-

demics held their assemblies. It took its name from one Academus, or Ecademus, a citizen of Athens; as our modern academies takes theirs from it. This term was also used metaphorically, to denote the sect of Academic philosophers. See ACADEMICS.

ACADEMY, in a modern sense, signifies a society of learned men, established for the improvement of arts or sciences. See SOCIETY.

ACÆNA, in botany, a genus of the Tetrandria Monogynia class and order of plants. There is but a single species, which is a Mexican plant.

ACALYPHA, in botany, a genus of plants belonging to the Monoecia Monodelphia class, and the natural order of Tricoccæ, called the Tick-fruit. There are fourteen species: the A. virginica; grows naturally in Virginia, and in Ceylon: the A. virgata is a native of the warmest countries, and grows plentifully in Jamaica; its leaves resemble those of the annual nettle, and sting as much. Most of the other species are natives of the West Indies. The plants have no beauty to recommend them, and are preserved in some botanic gardens merely on account of variety.

ACANTHA, among botanists, a name given to the prickles of thorny plants.

ACANTHA is also used by zoologists for the spines of certain fishes, as those of the echinus marinus, &c.

ACANTHACEOUS, among botanists, an epithet given to all the plants of the thistle kind, on account of the prickles with which they are beset.

ACANTHONOTUS, in natural history, a genus of fishes of the order Abdominales: the generic character is, body elongated, without dorsal fin: spines several, on the back and abdomen. There is but one species, the nasus, about 30 inches long, a native of the East Indies. The eyes are large, and the nostrils conspicuous: the body, which is of a moderate width for about the third of its length, gradually decreases or tapers towards the extremity: both head and body are covered with small scales, and are of a bluish tinge, with a silvery cast on the abdomen: the pectoral fins are brown, and of a moderate size: the ventral rather small, and of a similar colour: the lateral line is straight, and situated nearer to the back than to the abdomen: along the lower part of the back are ten strong but short spines, and beneath the abdomen twelve or thirteen others, which are followed by a small anal fin. (See plate I. Ichthyology, fig. 1.)

ACANTHURUS, in natural history, a genus of fishes, of the order Thoracici, of which the gen. character is, teeth small, in most species lobated: tail aculeated on each side: general habit and appearance like the genus Chætodon, which see. This genus consists of such species of the Linnæan genus Chætodon, as, in contradiction to the principal character of that genus, have moderately broad and strong teeth, rather than slender and setaceous ones: they are also furnished on each side the tail with a strong spine. There are twelve species, of which the principal is A. unicornis; this is the largest of the genus, growing to the length of three feet or more. It is a native of the Indian and Arabian seas, in the latter of which it is generally seen in large shoals of two or three hundred each, swimming with great strength, and feeding principally on different kinds of sea-weed. This fish was described by Grew, in his Museum of the Royal Society, under the name of the Lesser Unicorn fish. Fine specimens are to be found in the British and Leverian museums.

ACANTHUS, BEAR'S BREECH, or BRANK-URSINE, in botany, a genus of the Didynamia Angiospermia class, and belonging to the natural order of Personatæ. There are ten species: 1. The smooth acanthus, with white flowers, proceeding from about the middle to the top of the stalk, is the species used in medicine under the name of Branca ursina, or Brank-ursine. It is a native of Italy, about Naples, of Sicily, Provence, and the islands of the Archipelago, and is cultivated in our gardens, and flowers in June and July. Turner (in his Herbal in Hort. Kew.) informs us, that it was cultivated in Sion gardens so long ago as the year 1551. The leaves, and particularly the roots, abound with a soft, insipid mucilage, which may be readily extracted, either by boiling or by infusion. Rectified spirit digested on the leaves, extracts from them a fine deep green tincture, which is more durable than that which is communicated to spirit by other herbs. Brank-ursine is seldom or ever used medicinally in this country. But where it is common, it is employed for the same purposes to which the Althæa, or marsh-mallow, and other mucilaginous vegetables, are applied among us. In foreign countries the cow-parsnip is said to be substituted for it, though it possesses very different properties. The leaves of this species of acanthus accidentally growing round a basket covered with a tile, gave occasion to Callimachus to invent the Corinthian capital in architecture. 2. The

thistle-leaved acanthus was found by Sparrman at the Cape of Good Hope, and has many leaves, proceeding immediately from the root, resembling those of the thistle. 3. The prickly acanthus grows wild in Italy and Provence, and flowers from July to September. Its leaves are divided into segments, terminated with a sharp spine, which renders this plant troublesome to those who handle it. 4. The acanthus of Dioscorides, as Linnæus supposes it to be, grows naturally in the East, on Lebanon, &c. 5. The holly-leaved acanthus is an evergreen shrub, about four feet high, and separating into many branches, with leaves resembling those of the common holly, and bearing white flowers, similar to those of the common acanthus, but smaller. 6, 7, 8, 9. These species, viz. the entire-leaved, procumbent, forked, and Cape acanthi, are natives of the Cape of Good Hope. 10. The Madras acanthus is a native of the East Indies.

The smooth and prickly acanthi are perennial plants, and may be propagated either by seeds, which should be sown in a light dry soil towards the end of March, and left to grow, about six inches asunder, till autumn, when they should be transplanted where they are to remain: or by roots, which may be planted either in spring or autumn for the third sort; but the others must only be removed in the spring, because, if they are transplanted in autumn, they may be in danger of being destroyed by a cold winter. These plants take deep root, and when they are once established in a garden, they cannot be easily eradicated. The 5th and 10th species are too tender to thrive out of a stove in England, and cannot be propagated, except by seeds, which do not ripen in Europe. The other sorts must be treated in the same manner with Cape plants.

Acanthus, in architecture, an ornament representing the leaves of the herb acanthus, and used in the capitals of the Corinthian and Composite orders. See Architecture.

ACARNA, in botany, a genus belonging to the Syngenesia Æqualis class and order: receptacle chaffy, down feathery: calyx imbricate, invested with scales, corol. floscular. There are seven species.

ACARUS, the tick or mite, in natural history, so called, because it is deemed so small that it cannot be cut, is a genus of insects belonging to the order of Aptera, in the Linnæan system. Gmelin, in the last edition of Linnæus's system, has eighty-two species; of which, some are inhabitants of the earth, others of water: some live on trees and plants, others among stones, and others on the bodies of other animals, and even under their skin. The generic character is, legs eight; eyes two, situated on each side the head: feelers two, jointed; egg-shaped. The most familiar species are, 1. the A. siro, or common cheese-mite, which is a favourite subject for microscopic observations. This insect is covered with hairs or bristles, which resemble in their structure the awns of barley, being barbed on each side with numerous sharp-pointed processes. The mite is oviparous: from the eggs proceed the young animals, resembling the parents in all respects, except in the number of legs, which at first amount only to six, the pair from the head not making their appearance till after casting their first skin. The eggs in warm weather hatch in about a week, and the young animal may sometimes be seen for a day together struggling to get rid of its egg-shell. The mite is a very voracious animal, feasting equally upon animal and vegetable substances. It is also extremely tenacious of life; for, upon the authority of Leewenhoek, though highly discreditable to his sense of humanity, we are assured that a mite lived eleven weeks glued to a pin, in order for him to make observations on. 2. The A. exulcerans, or itch mite, is a species of considerable curiosity, on account of the structure of its limbs: it is slightly rounded, and of a flattened shape, with the thighs of the two upper pair of legs extremely thick and short: the two lower pair of legs have thick thighs, proceeding from a very slender base, and are extended into a long, stout, curved, and sharp-pointed bristle. Dr. Bononio, an Italian physician, was the first who contended that the itch was occasioned by this insect, an account of which may be found in the Philosophical Transactions, No. 283. Dr. Baker is inclined to think that it constitutes the *psora*, a species of itch distinct from others confounded with it. 3. A. autumnalis, or harvest-bug, of a bright red colour, with the abdomen beset on its hind part with numerous white bristles. It attaches itself to the skin, and is with difficulty disengaged. On the part where it fixes, it causes a tumour, about the size of a small bead, accompanied by a severe itching. The *tick* is of this species, which is to be found on dogs and other animals. Many of the acari attach themselves to insects of a larger kind, and hence they take their names, as A. coleopterous, found on the

black beetle. (See plate I. Entomology, fig. 1. and 2.)

These insects, which are often very troublesome on plants, and in hot-houses, may be effectually destroyed by the following mixture. Take two ounces of soft green soap, one ounce of common turpentine, and one ounce of flour of sulphur; pour upon these ingredients a gallon of boiling water, work the whole together with a whisk, and let the mixture be used warm. This mixture may also be of use for preventing the mildew on the peach and apricot; but it should never be used on fruit-trees near the time when their fruits are ripening. A strong ley made of wood-ashes will likewise destroy the acari; but plants are greatly injured by this, and by briny and spirituous compositions.

ACAULOSE, or Acaulous, among botanists, a term used for such plants as have no *caulis* or stem. See Caulis.

ACCEDAS *ad curiam*, in law, a writ lying where a man hath received, or fears false judgment, in a hundred-court, or court baron. It is issued out of the Chancery, and directed to the sheriff, but returnable in the King's-bench or Common-pleas. It lies also for justice delayed, and is said to be a species of the writ *Recordare*.

ACCELERATION, in mechanics, denotes the augmentation or increase of motion in accelerated bodies.

The term acceleration is chiefly used in speaking of falling bodies, or the tendency of heavy bodies towards the centre of the earth produced by the power of gravity; which, acting constantly and uniformly upon them, they must necessarily acquire every instant a new increase of motion. See Gravitation.

ACCELERATOR. See Anatomy.

ACCENT, among grammarians, is the raising or lowering of the voice in pronouncing certain syllables of words.

We have three kinds of accents, viz. the acute, the grave, and circumflex. The acute accent, marked thus (′), shews that the voice is to be raised in pronouncing the syllables over which it is placed. The grave accent is marked thus (`), and points out when the voice ought to be lowered. The circumflex accent is compounded of the other two, and marked thus (˜ or ˆ): it denotes a quavering of the voice between high and low. Some call the long and short quantities of syllables accents; but erroneously.

Accent, in music, a term applicable to every modulation of the voice, both in speaking and in singing. It is to the study of this that the composer and performer should unceasingly apply; since, without accent, there can be no music, because there can be no expression.

ACCEPTANCE, in common law, the tacitly agreeing to some act before done by another, which might have been defeated without such acceptance. Thus, if a husband and wife, seized of land in right of the wife, make a joint lease or feoffment, reserving rent, and the husband dies; after which the widow receives, or accepts the rent; such receipt is deemed an acceptance, confirms the lease of feoffment, and bars her from bringing the writ *cui in vita*.

Acceptance, among merchants, is the signing or subscribing a bill of exchange, by which the acceptor obliges himself to pay the contents of the bill.

Bills payable at sight are not accepted, because they must either be paid on being presented, or else protested for want of payment.

The acceptance of bills payable at a fixed day, at usance, or double usance, &c. need not be dated: because the time is reckoned from the date of the bill; but it is necessary to date the acceptance of bills payable at a certain number of days after sight, because the time does not begin to run till the next day after that acceptance: this kind of acceptance is made thus, *Accepted such a day and year*, and signed. See Exchange.

ACCESSARY, or Accessory, in common law, is chiefly used for a person guilty of a felonious offence, not principally, but by participation; as, by advice, command, or concealment. There are two kinds of accessaries; before the fact, and after it. The first is he who commands, or procures, another to commit felony, and is not present himself; for if he be present, he is a principal.

The second is he who receives, assists, or comforts any man that has done murder, or felony, whereof he has knowledge. A man may also be accessary to an accessary, by aiding, receiving, &c. an accessary in felony. An accessary in felony shall have judgment of life and member, as well as the principal, who did the felony: but not till the principal be first attainted, and convicted, or outlawed thereon. Where the principal is pardoned without attainder, the accessary cannot be arraigned; it being a maxim in law, Ubi non est principalis, non potest esse accessorius. But if the principal be pardoned, or have his clergy after attainder, the accessary shall be arraigned. 4 and 5 W. and M

cap. 4; and by stat. 1 Anne, cap. 9, it is enacted, that where the principal is convicted of felony, or stands mute, or challenges above twenty of the jury, it shall be lawful to proceed against the accessary in the same manner as if the principal had been attainted; and notwithstanding such principal shall be admitted to his clergy, pardoned, or delivered, before attainder. In some cases, also, if the principal cannot be taken, then the accessary may be prosecuted for a misdemeanor, and punished by fine, imprisonment, &c. stat. ib. see stat. 5 Anne, cap. 31. In the lowest and highest offences there are no accessaries, but all are principals; as in riots, routs, forcible entries, and other trespasses, which are the lowest offences. So also in the highest offence, which is, according to our law, high treason, there are no accessaries. Cok. Littlet 71.

ACCIDENT. See Logic.

ACCIPITRES, or rapacious birds, in the Linnæn system of ornithology, the first order of birds; the characters of which are, that the bill bends downwards, that the upper mandible is dilated a little on both sides towards the point, or armed with a tooth-like process, and that the nostrils are wide; the legs are short and strong; the feet are of the perching kind, having three toes forwards and one backwards; the toes are warty under the joints, with claws hooked, and sharp at the points. The body, head, and neck, are musculous, and the skin very tough. The birds of this order subsist by preying on other animals, and on dead carcases, and they are unfit for food. They live in pairs, and are monogamous; and build their nests in lofty situations. The female is generally larger and stronger than the male, and usually lays four eggs at a time. This order corresponds to that of Feræ, and comprehends four generas, viz. Vultur, Falco, Strix, and Lanius, which see.

ACCOMPANIMENT, in heraldry, denotes any thing added to a shield by way of ornament, as the belt, mantling, supporters, &c.

Accompaniment is also used for several bearings about a principal one, as a saltier, bend, fess, &c.

ACCOMPLICE, in law, a person who was privy to, or aiding in, the perpetration of some crime. See Accessary.

ACCORD, in law, a verbal agreement between two or more, where any one is injured by a tresspass, or other offence committed, to make satisfaction to the injured party; who, after the accord is performed, will be barred in law from bringing any new action against the aggressor for the same tresspass. It is safest, however, in pleading, to allege satisfaction, and not accord alone; because, in this last case, a precise execution in every part thereof must be alleged; whereas, in the former, the defendant needs only say, that he paid the plaintiff such a sum in full satisfaction of the accord, which he received.

ACCOUNTANT-*general* in the court of Chancery, an officer appointed by act of parliament to receive all monies lodged in court, and convey the same to the bank of England for better security. The salary of this officer and his clerks is to be paid out of the interest made of part of the money, it not being allowable to take fees in this office. Counterfeiting the hand of the accountant-general is felony, without clergy, by 12 Geo. I. c. 32.

ACCOUTREMENTS, in a military sense, signify the furniture of a soldier, such as puffs, belts, pouches, cartridge-boxes, &c.

ACCROCHE', in heraldry, denotes a thing's being hooked into another.

ACER, *maple*, in botany, a genus of the Monoecia order and Polygamia class of plants, and belonging to the natural order of Trihilata. There are 25 species. See Maple.

ACETATES, in chemistry, a genus of salts formed by the acetic acid. They may be distinguished by the following properties: they are decomposed by heat; the acid being partly driven off, partly destroyed:—they are very soluble in water:—when mixed with sulphuric acid, and distilled in a moderate heat, acetic acid is disengaged:—when they are dissolved in water, and exposed to the open air, their acid is gradually decomposed.

ACETIC *acid*, in chemistry. This acid is employed in different states, which have been distinguished from each other by peculiar names. When first prepared, it is called *vinegar*; when purified by distillation, it assumes the name of distilled vinegar, usually called *acetous* acid: when concentrated as much as possible by certain processes, it is called in the shops radical vinegar; but by chemists it is denominated *acetic* acid. One hundred parts of acetic acid are composed of

50.19 oxygen
13.94 hydrogen
35.87 carbon

100.00

ACETITES, a genus of salts formed by the acetous acid.

ACETOUS *acid*. See ACETIC ACID.

ACHANIA, in botany, a genus of the Monadelphia Polyandria class, and the natural order of Columniferæ. There are three species, viz. the A. malvaviscus, scarlet achania, or bastard hibiscus, which is a native of Mexico and Jamaica; cultivated here in 1714 by the Dutchess of Beaufort, and flowering through the greatest part of the year: the mollis, or woolly achania, a native of South America and the West India islands, found in Jamaica by Houstoun, in 1730, and introduced in 1780 by B. Bewick, Esq. and flowering in August and September: and the pilosa, or hairy achania, a native of Jamaica; introduced in 1780 by Mr. G. Alexander, and flowering in November. Achania is generally propagated by cuttings, which are planted in pots of light earth, plunged into a gentle hot-bed, and kept from the air till they take root, when they should be gradually inured to the open air. They must be preserved in winter in a moderate stove; and, kept warm in summer, they will flower, and sometimes ripen fruit.

ACHERNER, in astronomy, a star of the first magnitude in the southern extremity of the constellation Eridanus. See the article ERIDANUS.

ACHILLEA, milfoil, in botany, so called from Achilles, who is supposed to have acquired some knowledge of botany from his master Chiron, and to have used this plant for the cure of wounds and ulcers; a genus of the Syngenesia Polygamia Superflua class of plants, and of the natural order of Compositæ Discoideæ. There are 27 species, of which the most remarkable are the ptarmica, or sneezewort, M. growing wild in all the temperate parts of Europe, found in Britain, not uncommonly in meadows, by the sides of ditches, on the balks of corn fields, in moist woods and shady places. The shoots are put into salads, and the roots, being hot and biting, are used for the tooth-ache, whence the plant has been called bastard pellitory, and, on account of the form of the leaf, goose-tongue: the powder of the dried leaves, used as snuff, provokes sneezing, whence the name: in Siberia, a decoction of the whole herb is said to be successfully used in internal hemorrhages: of this plant there is a variety with double flowers, called batchelor's buttons; it flowers in July and August, and makes a tolerable appearance; and the millefolium, common M. or yarrow; abundant in pastures and by the sides of roads, flowering from June to September: mixed instead of hops by the inhabitants of Dalecarlia in their ale, in order to give it an inebriating quality: recommended by Anderson, in his Essays on Agriculture, for cultivation, though thought to be a noxious weed in pastures: the bruised herb, fresh, is recommended by Linnæus as an excellent vulnerary and styptic, and by foreign physicians in hemorrhages, and thought by Dr. Hill to be excellent in dysenteries, when administered in the form of a strong decoction. An ointment is made of it for the piles, and for the scab in sheep; and an essential oil is extracted from the flowers; but it is not used in the present practice.

ACHRAS, or SAPOTA-PLUM, in botany, a genus of the Hexandria Monogynia class, and of the natural order of Dumosæ. There are four species, viz. The mammosa, or mamme sapota, otherwise called nippled S. or American marmelade; growing in America to the height of thirty or forty feet, with leaves a foot long, and three inches broad in the middle, cream-coloured flowers, and large oval fruit, containing a thick, luscious pulp, called natural marmelade. This tree is planted for the fruit in Jamaica, Barbadoes, Cuba, and most of the West India islands, and was cultivated here by Mr. Miller in 1739. Of this there is a variety called the bully, or nisberry bully-tree, because it is the tallest of all the trees in the woods: it is esteemed one of the best timber trees in Jamaica. 2. The sapota, which grows to the height of sixty or seventy feet, without knots or branches, and bears a round, yellow fruit, bigger than a quince, which smells well, and is of an agreeable taste. It is common at Panama, and some other places in the Spanish West Indies, but not to be found in many of the English settlements. It was cultivated here by Mr. Miller in 1739. 3. The dissecta, or cloven-flowered S. cultivated in Malabar for the fruit, which is of the form and size of an olive, having a pulp of a sweetish acid flavour. Its leaves are used for cataplasms to tumours, bruised and boiled with the root of curcuma and the leaves of ginger; supposed to be a native of the Philippine islands, and probably growing in China, and found by Forster flowering in September, in the island of Tongatabu. 4. The salicifolia, or white willow S. called in Jamaica the white-bully-tree, or galimeta wood, which supplies good timber. The bark of the sapota and mammosa is very astringent, and is called *cortex Jamaicensis*. This was once supposed to be the true Jesuits bark,

but its effects on the negroes has been pernicious. These trees cannot be preserved in England but with great care and much heat.

ACHROMATIC, an epithet expressing a want of colour, introduced into astronomy by De la Lande.

ACHROMATIC *telescopes*, are telescopes contrived to remedy the aberrations in colours. They were invented by Mr. John Dolland, optician. See OPTICS, TELESCOPE.

ACHYRANTHES, in botany, a genus of the Pentandria Monogynia class of plants, belonging to the natural order of Miscellaneæ. There are eleven species, but they have but little beauty, and are only preserved in botanic gardens.

ACHYRONIA, in botany, a genus of the Diadelphia Decandria class and order, calyx five-toothed; the lower tooth elongated and cloven: legume compressed, many-seeded; one species, viz. A. villosa, a shrub found in New Holland, with long silky hairs: leaves lanceolate, acute, entire, with silky hair round the margin.

ACIA, in botany, a genus of the Monodelphia Dodecandria class and order: calyx five-parted, five petals, drupe dry, coriaceous, fibrous, one-seeded. Two species, trees sixty feet high, found in Guiana.

ACICARPHA, in botany, a genus of the Polygamia Necessaria class and order: receptacle chaffy, the chaff uniting with the seeds after flowering; seeds naked; florets tubular; calyx five-parted. One species, found in Buenos Ayres.

ACID, in chemistry, a term originally synonymous with *sour*, and applied only to bodies distinguished by that taste; but it now comprehends under it all substances possessed of the following properties. Acids, when applied to the tongue, excite the sensation of sour, they change the blue colours of vegetables to a red; they unite with water in almost any proportion; they combine with all the alkalies, and most of the metallic oxides and earths, and form with them those compounds called in chemistry salts. Every acid does not possess all these properties, but they all possess a sufficient number to distinguish them from other substances. See CHEMISTRY.

ACIDIFIABLE *base*, or RADICAL, any substance capable of uniting, without decomposition, with such a quantity of oxygen as to become possessed of acid properties. Almost all the acids agree with each other in containing oxygen, but they differ in their bases, which determine the species of the acid. Sulphur combined with certain portions of oxygen forms sulphurous or sulphuric acid, according to the quantity of oxygen absorbed.

ACIDOTON, in botany, a genus of the Monoecia Polyandria class and order; it has male and female flowers on the same, or a different tree. There is but one species, viz. A. urens, a native of Jamaica, which grows to the height of eight or nine feet.

ACIPENSER, a genus of fishes of the order Cartilagenei: the characters are, that the head is obtuse, the mouth is under the head, retractile, and without teeth; that the four cerri are below the front, and before the mouth; the aperture of the gills is at the side, the body is elongated, and angulated with many series of scuta, or scaly protuberances. These may be ranked among the larger fish; are inhabitants of the sea, but ascend rivers annually; the flesh of all of them is delicious; from the roe is made caviar, and from the sounds and muscular parts is made isinglass; they feed on worms, and other fishes; the females are larger than the males. There are five species: A. sturio, or common sturgeon, inhabits European, Mediterranean, Red, Black, and Caspian seas, and annually ascends rivers in the spring. (See plate I. Ichthyology, fig. 2.) A. schypa, inhabits the Caspian sea, and large lakes of Siberia. A. ruthenus, and A. stellatus, both inhabit the Caspian sea. A. hufo, inhabits the Danube, Wolga, and other Russian rivers, and also the Caspian. The skin of this species is so hard and tough, as to be used for carriage traces. See STURGEON.

ACNIDA, Virginia hemp, in botany, a genus of the Pentandria Pentagynia class and order. There is but a single species, viz. A. cannabina, which is a native of Virginia, and some other parts of America; it is seldom cultivated in Europe.

ACONITUM, aconite, wolf's-bane, or monk's-hood, in botany, a genus of plants of the Trigynia order and Polyandria class, and pertaining to the natural order of Multisiliquæ. In the last edition of Linnæus, by Gmelin, this genus comprehends fourteen species; most of the species of aconite have been deemed poisonous. The ancients were so surprised at their pernicious effects, that they were afraid to touch the plants; and hence sprung many superstitious precautions about the manner of gathering them. Theophrastus relates that there was a mode of preparing the aconite in his days, so that it should only destroy at the end of one or two years. But some have

questioned whether the aconite of Theophrastus, Dioscorides, Pliny, and other ancient writers, be the same with ours, or should be referred to the genus of Ranunculus. It is confidently affirmed that the huntsmen on the Alps, who hunt the wolves and other wild animals, dip their arrows into the juice of these plants, which renders the wounds occasioned by them mortal. A decoction of the roots has been used to kill bugs; and the powder, disguised in bread, or some other palatable vehicle, has been employed to destroy rats and mice. The A. napellus, or common monk's-hood, has been long known as one of the most virulent of all vegetable poisons. Linnæus says that it is fatal to swine and goats, but does no injury to horses, who eat it dry. He also informs us, from the Stockholm Acts, that an ignorant surgeon died in consequence of taking the fresh leaves, which he prescribed to a patient. The effluvia of the herb in full flower have produced swooning fits, and a temporary loss of sight. The leaves and shoots of this plant, used as salad, instead of celery, have proved fatal in several instances. But the most powerful part of the plant is the root. Matthiolus relates, that it was given by way of experiment to four condemned criminals, two at Rome, in 1524, and two at Prague, in 1561, two of whom soon died, and the other two, with great difficulty, were recovered. The juice applied to the wound of a finger, not only produced pain in the arm and hand, but cardialgia, anxiety, sense of suffocation, syncope, &c. and the wounded part sphacelated before it came to suppuration. Dodonæus says that five persons at Antwerp died in consequence of eating it by mistake. The effects of this plant are, convulsions, giddiness, insanity, violent evacuations, both upwards and downwards, faintings, cold sweat, and even death itself. Nevertheless it has been used for medical purposes. The Indians are said to use aconite, corrected in cow's urine, with good success against fevers. There is one species of it which has been deemed an antidote to those that are poisonous, called anthora, and those that are poisonous are called thora. The taste of the root of the species denominated anthora is sweet, with a mixture of bitterness and acrimony, and the smell is pleasant. It purges violently when fresh, but loses its qualities when dried. This is poisonous as well as the others, though in a slighter degree, and is disused in the present practice. The first person who ventured to introduce the common monk's-hood into medicine was Dr. Stoerck. Stoerck recommends two grains of the extract to be rubbed into a powder, with two drams of sugar, and to begin with ten grains of this powder two or three times a-day. The extract is often given from one grain to ten for a dose; and some have considerably increased the quantity. Instead of the extract, a tincture has been made of the dried leaves, macerated in six times their weight of spirits of wine, and forty drops given for a dose.

ACORN, an ornamental piece of wood, in the shape of a cone, fixed to the top of the spindle of a mast-head, above the vane, to keep it from coming off the spindle.

ACORUS, in botany, the sweet flag, or sweet rush, a genus of the Monogynia order, and Hexandria class of plants, and belonging to the natural order of Piperitæ. There are two species, viz. the A. calamus, or common sweet rush, of which there are two varieties, the vulgaris, or European sweet rush, or calamus aromaticus, and the Asiaticus or Indian calamus aromaticus. The common calamus aromaticus grows naturally on the banks of the rivers, and in shallow standing waters; and is found in many parts of England, but is much more plentiful in the standing waters of Holland, and is common in many other parts of Europe. The Indian calamus, which grows not only in marsh ditches, but in more elevated and dry places, in Malabar, Ceylon, Amboyna, and other parts of the East Indies, differs but little from the European, except that it is more tender and narrow, and of a more hot and pungent taste; and A. gramineus, or Chinese sweet-grass, has the roots in tufts, with a few thready fibres. The whole herb has an aromatic smell when bruised, resembling the English sweet-flag, from which it is distinguished by the shortness of that portion of its stalk which is above the spadix, as well as by all its parts, except the florets, being five times smaller than in that plant. It is probably a native of China, and cultivated, for the sake of its smell, in pots near the habitations of the Chinese. The sweet flag will succeed very well in moist garden ground, but never produces its spikes, unless it grows in water. The dried roots of the calamus aromaticus are commonly imported from the Levant, though those grown in England are equally good. They have a strong aromatic smell, and a warm pungent taste; the flavour is much improved by drying. The powdered root might

perhaps supply the place of foreign spices; and indeed it is the only native aromatic plant of northern climates. It is carminative and stomachic, and often used as an ingredient in bitter infusions.

ACOTYLEDONES, in botany, plants so called, because their seeds are not furnished with lobes, and of course put forth no seminal leaves. All mosses are of this kind. See COTYLEDONES.

ACOUSTICS, in physics, is that science which instructs us in the nature of sound. It is divided by some writers into diacoustics, which explains the properties of those sounds that come distinctly from the sonorous body to the ear; and catacoustics, which treats of reflected sounds; but this distinction is not necessary. In the infancy of philosophy, sound was held to be a separate existence: it was conceived to be wafted through the air to our organs of hearing, which it was supposed to affect in a manner resembling that in which our nostrils are affected when they give us the sensation of smell. Yet, even in those early years of science, there were some, and, in particular, the celebrated founder of the Stoic school, who held that sound, that is, the cause of sound, was only the particular motion of external gross matter, propagated to the ear, and there producing that agitation of the organ, by which the soul is immediately affected with the sensation of sound. Zeno says, "Hearing is produced by the air which intervenes between the thing sounding and the ear. The air is agitated in a spherical form, and moves off in waves, and falls on the ear, in the same manner as water undulates in circles when a stone has been thrown into it." The ancients were not remarkable for precision, either of conception or argument, in their discussions, and they were contented with a general and vague view of things. Some followed the opinion of Zeno, without any farther attempts to give a distinct conception of the explanation, or to compare it with experiment. But, in latter times, during the ardent researches into the phenomena of nature, this became an interesting subject of inquiry. The invention of the air-pump gave the first opportunity of deciding, by experiment, whether the elastic undulations of air were the causes of sound; and the trial fully established the point; for a bell rung in vacuo gave no sound, and one rung in condensed air gave a very loud one. It was therefore received as a doctrine in general physics, that air was the vehicle of sound. The celebrated Galileo, the parent of mathematical philosophy, discovered the nature of that connection between the lengths of musical chords and the notes which they produced, which had been observed by Pythagoras, or learned by him in his travels in the East, and which he made the foundation of a refined and beautiful science, the theory of music. Galileo shewed, that the real connection subsisted between the tones and the vibrations of these chords, and that their different degrees of acuteness corresponded to the different frequency of their vibrations. The very elementary and familiar demonstration which he gave of this connection did not satisfy the curious mathematicians of that inquisitive age, and the mechanical theory of musical chords was prosecuted to a great degree of refinement. In the course of this investigation, it appeared that the chord vibrated in a manner precisely similar to a pendulum vibrating in a cycloid. It must therefore agitate the air contiguous to it in the same manner: and thus there is a particular kind of agitation that the air can receive and maintain, which is very interesting.

Sir Issac Newton took up this question as worthy of his notice; and endeavoured to ascertain with mathematical precision the mechanism of this particular class of undulations, and gave us the principal theorems concerning the undulations of elastic fluids, which make the 47, &c. Propositions of Book II. of his Principles of Natural Philosophy. They have been considered as giving the doctrines concerning the propagation of sound. Most sounds, we all know, are conveyed to us by means of the air. In whatever manner they either float upon it, or are propelled forward in it, certain it is, that, without the vehicle of this or some other fluid, we should have no sounds at all. Let the air be exhausted from a receiver, and a bell will emit no sound; for, as the air continues to grow less dense, the sound dies away in proportion, so that at last its strongest vibrations are almost totally silent. Thus air is a vehicle for sound. However, we must not, with some philosophers, assert, that it is the only vehicle; that, if there were no air, we should have no sounds whatsoever: for it is found, by experiment, that sounds are conveyed through water with the same facility with which they move through air. A bell rung in water returns a tone as distinct as if rung in air. This was observed by Dr. Derham, who also remarked, that the tone came a quarter deeper. It appears from the experiments of naturalists, that fishes have a strong perception of sounds, even

at the bottom of deep rivers. From hence it would seem not to be very material in the propagation of sounds, whether the fluid which conveys them be elastic or otherwise. Water, which, of all substances that we know, has the least elasticity, yet serves to carry them forward: and if we make allowance for the difference of its density, perhaps the sounds move in it with a proportionable rapidity to what they are found to do in the elastic fluid of air. But though air and water are both vehicles of sound, yet neither of them, according to some philosophers, seems to be so by itself, but only as it contains an exceedingly subtle fluid, capable of penetrating the most solid bodies. One thing, however, is certain, that whatever sound we hear is produced by a stroke, which the sounding body makes against the fluid, whether air or water. The fluid, being struck upon, carries the impression forward to the ear, and there produces its sensation. Philosophers are so far agreed, that they all allow that sound is nothing more than the impression made by an elastic body upon the air or water, and this impression carried along by either fluid to the organ of hearing. But the manner in which this conveyance is made is still disputed: whether the sound is diffused into the air, in circle beyond circle, like the waves of water when we disturb the smoothness of its surface by dropping in a stone; or whether it travels along, like rays diffused from a centre, somewhat in the swift manner that electricity runs along a rod of iron; these are the questions which have divided the learned. Newton was of the first opinion. He has explained the progression of sound by an undulatory, or rather a vermicular, motion in the parts of the air. If we have an exact idea of the crawling of some insects, we shall have a tolerable notion of the progression of sound upon this hypothesis. The insect, for instance, in its motion, first carries its contractions from the hinder part, in order to throw its fore part to the proper distance, then it carries its contractions from the fore part to the hinder, to bring that forward. Something similar to this is the motion of the air when struck upon by a sounding body. All who have remarked the tone of a bell, while its sounds are decaying away, must have an idea of the pulses of sound, which, according to Newton, are formed by the air's alternate progression and recession. And it must be observed, that as each of these pulses is formed by a single vibration of the string, they must be equal to each other; for the vibrations of the string are known to be so. Again, as to the velocity with which sounds travel, this Newton determines, by the most difficult calculation that can be imagined, to be in proportion to the thickness of the parts of the air, and the distance of these parts from each other. From hence he goes on to prove, that each little part moves backward and forward like a pendulum; and from thence he proceeds to demonstrate, that if the atmosphere were of the same density every where as at the surface of the earth, in such a case, a pendulum, that reached from its highest surface down to the surface of the earth, would, by its vibrations, discover to us the proportion of the velocity with which sounds travel. The velocity with which each pulse would move, he shows, would be as much greater than the velocity of such a pendulum swinging with one complete vibration, as the circumference of a circle is greater than the diameter. From hence he calculates that the motion of sound will be 979 feet in one second. But this not being consonant to experience, he takes in another consideration, which destroys entirely the rigour of his former demonstration, namely, vapours in the air, and then finds the motion of sound to be 1142 feet in one second, or near 13 miles in a minute, a proportion which experience had established nearly before. Many other theories on this subject have been advanced by ingenious men, but our limits do not allow to enter farther into them.

Since by experiments it has been proved that sound travels at about the rate of 1142 feet in a second, and that no obstacles hinder its progress, a contrary wind only a small matter diminishing its velocity, the method of calculating its progress is easily made known. When a gun is discharged at a distance, we see the fire long before we hear the sound. If then we know the distance of the place, and know the time of the interval between our first seeing the fire and hearing the report, this will shew us exactly the time that the sound has been travelling to us. For instance, if the gun is discharged a mile off, the moment the flash is seen you take a watch, and count the seconds till you hear the sound, the number of seconds is the time the sound has been travelling a mile. We are also enabled to find the distance between objects that would be otherwise immeasureable. For example; suppose you see the flash of a gun in the night at sea, and tell seven seconds before you hear the report, it follows therefore that the

distance is seven times 1142 feet. In like manner, if you observe the number of seconds between the lightning and the report of the thunder, you know the distance of the cloud from whence it proceeds. But, according to another philosopher, Dr. Thomas Young, the velocity of sound is not quite so great. "It has been demonstrated," he observes, "by M. De La Grange and others, that any impression whatever, communicated to one particle of an elastic fluid, will be transmitted through that fluid with an uniform velocity, depending on the constitution of the fluid, without reference to any supposed laws of the continuation of that impression. Their theorem for ascertaining this velocity is the same as Newton has deduced from the hypothesis of a particular law of continuation: but it must be confessed, that the result differs somewhat too widely from experiment to give us full confidence in the perfection of the theory. Corrected by the experiments of various observers, the velocity of any impression transmitted by the common air may, at an average, be reckoned 1130 feet in a second." Phil. Trans. vol. XC.

Dr. Derham has proved by experiment, that all sounds whatever travel at the same rate. The sound of a gun, and the striking of a hammer, are equally swift in their motions; the softest whisper flies as swiftly, as far as it goes, as the loudest thunder. To these we may add, that smooth and clear sounds proceed from bodies that are homogeneous, and of an uniform figure; and harsh or obtuse sounds, from such as are of a mixed matter and irregular figure. The velocity of sounds is to that of a brisk wind as fifty to one. The strength of sounds is greatest in cold and dense air, and least in that which is warm and rarefied. Every point against, which the pulses of sound strike, becomes a centre, from which a new series of pulses are propagated in every direction. Sound describes equal spaces in equal times.

There is probably no substance which is not in some measure a conductor of sound; but sound is much enfeebled by passing from one medium to another. If a man, stopping one of his ears with his finger, stops the other also by pressing it against the end of a long stick, and a watch be applied to the opposite end of the stick, or of a piece of timber, be it ever so long, the beating of the watch will be distinctly heard; whereas, in the usual way, it can scarcely be heard at the distance of 15 or 18 feet. The same effect will take place if he stops both his ears with his hands, and rests his teeth, his temple, or the cartilaginous part of one of his ears, against the end of the stick. Instead of a watch, a gentle scratch may be made at one end of a pole or rod, and the person who keeps the ear in close contact with the other end of the pole will hear it very plainly. Thus, persons who are dull of hearing may, by applying their teeth to some part of an harpsichord, or other sounding body, hear the sound much better than otherwise.

If a person tie a poker or any other piece of metal on to the middle of a strip of flannel about a yard long, then press with his thumbs or fingers the ends of the flannel into his ears, while he swings the poker against any obstacle, as an iron or steel fender, he will hear a sound very like that of a large church bell.

Sound, like light, after it has been reflected from several places, may be collected in one point, as into a focus; and it will be there more audible than in any other part, even that at the place from whence it proceeded. On this principle it is that a whispering gallery is constructed. The form of a whispering gallery must be that of a concave hemisphere, as ABC, plate Acoustics, fig. 2.; and if a low sound or whisper be uttered at A, the vibrations expanding themselves every way will impinge on the points D, D, D, &c. and from thence be reflected to E, E, E, and from thence to the points F and G, till at last they all meet in C, where the sound will be the most distinctly heard. The augmentation of sound, by means of speaking-trumpets, is usually illustrated in the following manner: Let ABC, fig. 3. be the tube, BD the axis, and B the mouth-piece for conveying the voice to the tube. Then it is evident, when a person speaks at B in the trumpet, the whole force of his voice is spent upon the air contained in the tube, which will be agitated through its whole length, and, by various reflections from the side of the tube to the axis, the air along the middle part of the tube will be greatly condensed, and its momentum proportionably increased, so that when it comes to agitate the air at the orifice of the tube AC, its force will be as much greater than what it would have been without the tube, as the surface of a sphere, whose radius is equal to the length of the tube, is greater than the surface of the segment of such sphere, whose base is the orifice of the tube. For a person speaking at B, without the tube, will have the force of his voice spent in exciting concentric superficies of air all round the point B; and when

those superficies or pulses of air are diffused as far as D every way, it is plain the force of the voice will there be diffused through the whole superficies of a sphere whose radius is BD; but in the trumpet it will be so confined, that at its exit it will be diffused through so much of that spherical surface of air as corresponds to the orifice of the tube. But since the force is given, its intensity will be always inversely as the number of particles it has to move; and therefore in the tube it will be to that without, as the superficies of such a sphere to the area of the large end of the tube nearly. But it is obvious, Dr. M. Young observes, that the confinement of the voice can have little effect in increasing the strength of the sound, as this strength depends on the velocity with which the particles move. Were this reasoning conclusive, the voice should issue through the smallest possible orifice; cylindrical tubes would be preferable to any that increased in diameter; and the less the diameter, the greater would be the effect of the instrument; because the plate or mass of air to be moved would, in that case, be less, and consequently the effect of the voice the greater; all which is contradicted by experience. The cause of the increase of sound in these tubes must therefore be derived from some other principles: and among these we shall probably find, that what the ingenious Kircher has suggested is the most deserving of our attention. He tells us, that "the augmentation of the sound depends on its reflection from the tremulous sides of the tube; which reflections, conspiring in propagating the pulses in the same direction, must increase its intensity." Newton also seems to have considered this as the principal cause, in the scholium of Prop. 50, B. II. Princip. when he says, "We hence see why sounds are so much increased in stentorophonic tubes, for every reciprocal motion is, in each return, increased by the generating cause." Farther, when we speak in the open air, the effect on the tympanum of a distant auditor is produced merely by a single pulse. But when we use a tube, all the pulses propagated from the mouth, except those in the direction of the axis, strike against the sides of the tube, and every point of impulse becoming a new centre, from whence the pulses are propagated in all directions, a pulse will arrive at the ear from each of those points. Thus, by the use of a tube, a greater number of pulses are propagated to the ear, and consequently the sound increased. The confinement too of the voice may have a little effect, though not such as is ascribed to it by some; for the condensed pulses produced by the naked voice freely expand every way; but in tubes, the lateral expansion being diminished, the direct expansion will be increased, and consequently the velocity of the particles, and the intensity of the sound. The substance also of the tube has its effect; for it is found, by experiment, that the more elastic the substance of the tube, and consequently the more susceptible it is of these tremulous motions, the stronger is the sound. If the tube be laid on any non-elastic substance, it deadens the sound, because it prevents the vibratory motion of the parts. The sound is increased in speaking-trumpets, if the tube be suspended in the air; because the agitations are then carried on without interruption. These tubes should increase in diameter from the mouth-piece, because the parts vibrating in directions perpendicular to the surface will conspire in impelling forward the particles of air, and consequently, by increasing their velocity, will increase the intensity of the sound: and the surface also increasing, the number of points of impulse and of new propagation will increase proportionably. The several causes, therefore, of the increase of sound in these tubes, Dr. Young concludes to be, 1. The diminution of the lateral, and consequently the increase of the direct expansion and velocity of the included air. 2. The increase of the number of pulses by increasing the points of new propagation. 3. The reflections of the pulses from the tremulous sides of the tube, which impel the particles of air forward, and thus increase their velocity.

An umbrella, held in a proper position over the head, may serve to collect the force of a distant sound by reflection, in the manner of a hearing-trumpet; but its substance is too slight to reflect any sound perfectly, unless the sound fall on it in a very oblique direction. The exhibition of the Invisible Girl is said to depend on the reflection of sound; but the deception is really performed by conveying the sound through pipes artfully concealed, and opening opposite to the mouth of the trumpet, from which it seems to proceed.

When a portion of a pulse of a sound is separated by any means from the rest of the spherical or hemispherical surface to which it belongs, and proceeds through a wide space, without being supported on either side, there is a certain degree of divergence, by means of which it sometimes becomes audible in every part of the

medium transmitting it: but the sound thus diverging is comparatively very faint. Hence, in order that a speaking-trumpet may produce its full effect, it must be directed in a right line towards the hearer; and the sound collected into the focus of a concave mirror is far more powerful than at a little distance from it, which could not happen, if sound, in all cases, tended to spread equally in all directions. It is said that the report of a cannon appears many times louder to a person towards whom it is fired, than to one placed in a contrary direction. It must, says Dr. Young, have occurred to every one's observation, that a sound, such as that of a mill, or a fall of water, has appeared much louder after turning a corner, when the house or other obstacle no longer intervened. Indeed, the whole theory of the speaking-trumpet would fall to the ground, if it were demonstrable that sound spreads equally in all directions. In windy weather, it may be often observed, that the sound of a distant bell varies almost instantaneously in its strength, so as to appear twice as remote at one time as another. Now, if sound diverged equally in all directions, the variation produced by the wind would not exceed one-tenth of the apparent distance; but on the supposition of a motion nearly rectilinear, it may easily happen that a slight change in the direction of the wind shall convey a sound, either directly or after reflection, in very different degrees, to the same spot.

The decay of sound is the natural consequence of its distribution throughout a larger and larger quantity of matter, as it proceeds to diverge every way from its centre. The actual velocity of the particles of the medium transmitting it, appears to diminish, simply, in the same proportion as the distance from the centre increases; consequently, their energy, which is to be considered as the measure of the strength of sound, must vary as the square of the distance; so that, at the distance of ten feet from the sounding body, the velocity of the particles of the medium becomes one-tenth as great as at the distance of one foot, and their energy, or the strength of the sound, only one-hundredth as great.

An echo is a reflection of sound striking against some object, as an image is reflected in a glass: but it has been disputed, what are the proper qualities in a body for thus reflecting sounds. It is in general known, that caverns, grottoes, mountains, and ruined buildings, return this reflection of sound. We have heard of a very extraordinary echo, at a ruined fortress near Louvain, in Flanders. If a person sung, he only heard his own voice, without any repetition; on the contrary, those who stood at some distance heard the echo, but not the voice; but then they heard it with surprising variations, sometimes louder, sometimes softer, now more near, then more distant. There is an account, in the Memoirs of the French academy, of a similar echo near Rouen. It has been already observed, that every point against which the pulses of sound strike becomes the centre of a new series of pulses, and sound describes equal distances in equal times; therefore, when any sound is propagated from a centre, and its pulses strike against a variety of obstacles, if the sum of the right lines drawn from that point to each of the obstacles, and from each obstacle to a second point, be equal, then will the latter be a point in which an echo will be heard. Thus, let A, fig. 4, be the point from which the sound is propagated in all directions, and let the pulses strike against the obstacles C, D, E, F, G, H, I, &c. each of these points becomes a new centre of pulses by the first principles, and therefore from each of them one series of pulses will pass through the point B. Now, if the several sums of the right lines $\overline{AC} + \overline{CB}$, $\overline{AD} + \overline{DB}$, $\overline{AE} + \overline{EB}$, $\overline{AG} + \overline{GB}$, $\overline{AH} + \overline{HB}$, $\overline{AI} + \overline{IB}$, &c. be all equal to each other, it is obvious that the pulses propagated from A to these points, and again from these points to B, will all arrive at B at the same instant, according to the second principle; and, therefore, if the hearer be in that point, his ear will at the same instant be struck by all these pulses. Now it appears, from experiment, that the ear of an exercised musician can alone distinguish such sounds as follow one another at the rate of 9 or 10 in a second, or any slower rate; and therefore, for a distinct perception of the direct and reflected sound, there should intervene the interval of $\frac{1}{9}$ of a second; but in this time sound describes $\frac{1142}{9}$ or 127 feet nearly. And therefore, unless the sum of the lines drawn from each of the obstacles to the points A and B exceeds the interval AB by 127 feet, no echo will be heard at B. Since the several sums of the lines drawn from the obstacles to the points A and B are of the same magnitude, it appears that the curve passing through all the points, C, D, E, F, G, H, I, &c. will be an ellipse. Hence all the points of the obstacles which produce an echo must

lie in the surface of the oblong spheroid, generated by the revolution of this ellipse round its major axis. See CONIC SECTIONS. As there may be several spheroids of different magnitudes, so there may be several different echoes of the same original sound. And as there may happen to be a greater number of reflecting points in the surface of an exterior spheroid than in that of an interior, a second or a third echo may be much more powerful than the first, provided that the superior number of reflecting points, that is, the superior number of reflecting pulses propagated to the ear, be more than sufficient to compensate for the decay of sound which arises from its being propagated through a greater space. This is finely illustrated in the celebrated echoes at the lake of Killarney, in Kerry, where the first return of the sound is much inferior in strength to those which immediately succeed it. From what has been laid down it appears, that, for the most powerful echo, the sounding body should be in one focus of the ellipse, which is the section of the echoing spheroid, and the hearer in the other. However, an echo may be heard in other situations, though not so favourably; as such a number of reflected pulses may arrive at the same time at the ear, as may be sufficient to excite a distinct perception. Thus a person often hears the echo of his own voice; but for this purpose he should stand at least 63 or 64 feet from the reflecting obstacle, according to what has been said before.

If a bell, *a*, fig. 5, be struck, and the undulations of the air strike the wall *c d* in a perpendicular direction, they will be reflected back in the same line; and if a person be situated between *a* and *c*, as at *x*, he would hear the sound of the bell by means of the undulations as they went to the wall, and he would hear it again as they came back, after the reflection, which would be the echo of the sound. So a person standing at *x* might, in speaking in the direction of the wall *c d*, hear the echo of his own voice. But in both cases the distance *c x* must be 63 or 64 feet. If the undulations strike against the wall obliquely, they will be reflected off obliquely on the other side; if, for instance, a person stand at *m*, and there be any obstacle between that place and the bell, so as to prevent him hearing the direct sound, he may nevertheless hear the echo from the wall *c d*, provided the direct sound fall in that sort of oblique direction, so as to force the reflected undulations along the lime *c m*.

At the common rate of speaking, we do not pronounce above three syllables and a half, that is, seven half syllables in a second; therefore, that the echo may return just as soon as three syllables are expressed, twice the distance of the speaker from the reflecting object must be equal to 1000 feet; for as sound describes 1142 feet in a second, 6-7ths of that space, that is, 1000 feet nearly, will be described while six half, or three whole, syllables are pronounced; that is, the speaker must stand near 500 feet from the obstacle. And, in general, the distance of the speaker from the echoing surface, for any number of syllables, must be equal to the seventh part of the product of 1142 feet multiplied by that number. In churches we never hear a distinct echo of the voice, but a confused sound, when the speaker utters his words too rapidly; because the greatest difference of distance between the direct and reflected courses of such a number of pulses as would produce a distinct sound is never in any church equal to 127 feet, the limit of echoes. But though the first reflected pulses may produce no echo, both on account of their being too few in number, and too rapid in their return to the ear, yet it is evident, that the reflecting surface may be so formed, as that the pulses which come to the ear, after two reflections or more, may, after having described 127 feet or more, arrive at the ear in sufficient numbers, and also so nearly at the same instant, as to produce an echo, though the distance of the reflecting surface from the ear be less than the limit of echoes. This is confirmed by a singular echo in a grotto on the banks of the little brook called the Dinan, about two miles from Castlecomber, in the county of Kilkenny. As you enter the cave, and continue speaking loud, no return of the voice is perceived; but on your arriving at a certain point, which is not above 14 or 15 feet from the reflecting surface, a very distinct echo is heard. Now this echo cannot arise from the first course of pulses that are reflected to the ear, because the breadth of the cave is so small, that they would return too quickly to produce a distinct sensation from that of the original sound: it therefore is produced by those pulses, which, after having been reflected several times from one side of the grotto to the other, and having run over a greater space than 127 feet, arrived at the ear in considerable numbers, and not more distant from each other in point of time than the ninth part of a second. M. De la Grange demonstrated, that all impressions are reflected by an obstacle ter-

minating an elastic fluid, with the same velocity with which they arrived at that obstacle. When the walls of a passage, or of an unfurnished room, are smooth, and perfectly parallel, any explosion, or a stamping with the foot, communicates an impression to the air, which is reflected from one wall to the other, and from the second again towards the ear, nearly in the same direction with the primitive impulse: this takes place as frequently in a second, as double the breadth of the passage is contained in 1130 feet; and the ear receives a perception of a musical sound, thus determining its pitch by the breadth of the passage. On making the experiment, the result will be found accurately to agree with this explanation. If the sound is predetermined, and the frequency of vibrations such, as that each pulse, when doubly reflected, may coincide with the subsequent impulse, proceeding directly from the sounding body, the intensity of the sound will be much increased by the reflection; and also, in a less degree, if the reflected pulse coincides with the next but one, the next but two, or more of the direct pulses. The appropriate notes of a room may readily be discovered by singing the scale in it; and they will be found to depend on the proportion of its length or breadth to 1130 feet.

By altering our situation in a room, and expressing a sound, or hearing the sound of another person, in different situations, or when different objects are alternately placed in the room, that sound may be heard louder or weaker, and more or less distinct. Hence it is, that blind persons, who are under the necessity of paying great attention to the perceptions of their sense of hearing, acquire the habit of distinguishing, from the sound even of their own voices, whether a room is empty or furnished; whether the windows are open or shut; and sometimes they can even distinguish whether any person be in the room or not. A great deal of furniture in a room checks, in a great measure, the sounds that are produced in it, for they hinder the free communication of the vibrations of the air from one part of the room to the other. The fittest rooms for declamation, or for music, are such as contain few ornaments that obstruct the sound, and at the same time have the least echo possible.

A strong and continued sound fatigues the ear. The strokes of heavy hammers, of artillery, &c. are apt to make people deaf for a time: and it has been known that persons, who have been long exposed to the continued and confused noise of certain manufactories, or of water-falls, or other noisy places, can hear what is spoken to them much better in the midst of that noise than elsewhere.

We shall conclude this article with an experiment or two, for the amusement of the younger part of our readers.

Experiment 1. Place a concave mirror, AB, fig. 6, of two feet in diameter, in a perpendicular direction, and at the distance of about five or six feet from a partition EF, in which there is an opening equal in size to the mirror; against this opening must be placed a picture, painted in water-colours, on a thin cloth, that the sound may easily pass through it. Behind the partition, at the distance of a few feet, place another mirror GH, of the same size as the former, and directly opposite to it. At the point C is to be placed the figure of a man, seated on a pedestal, with his ear exactly in the focus of the first mirror; his lower jaw must be made to open by a wire, and shut by a spring. The wire must pass through the figure, and under the floor, to come up behind the partition. Let a person, properly instructed, be placed behind the partition, near the mirror; any one may now whisper into the ear of the image, with the assurance of being answered. The deception is managed by giving a signal to the person behind the partition, who, by placing his ear to the focus I of the mirror GH, will hear distinctly what the other said, and moving the jaw of the statue by the concealed wire, will return the answer directly, which will be heard distinctly by the first speaker.

Ex. 2. Let two heads of plaster of Paris be placed on pedestals, on opposite sides of a room. A tin tube of an inch in diameter must pass from the ear of one head through the pedestal under the floor, and go up to the mouth of the other. When a person speaks low into the ear of one bust, the sound is reverberated through the length of the tube, and will be distinctly heard by any one who shall place his ear to the mouth of the other. The end of the tube which is next the ear of the one head should be considerably larger than that end which comes to the mouth of the other. If there be two tubes, one going to the ear, and the other to the mouth of each head, two persons may converse together, by applying their mouth and ear reciprocally to the mouth and ear of the busts, while other people, standing in the middle of the room, between the heads, will not hear any part of the conversation.

Ex. 3. Fig. 7 is a representation of the Eolian harp, which was probably invented by Kircher. This instrument may be made by almost any carpenter; it consists of a long narrow box of very thin deal, about five or six inches broad, and two inches deep, with a circle in the middle of the upper side, of an inch and a half in diameter, in which is drilled small holes. On this side seven, ten, or more strings of very fine gut are stretched over bridges at each end, like the bridge of a fiddle, and screwed up or relaxed with screw-pins. The strings are all tuned to one and the same note; and the instrument is placed in some current of air, where the wind can pass over its strings with freedom. A window, of which the width is exactly equal to the length of the harp, with the sash just raised to give the air admission, is a proper situation. When the air blows upon these strings with different degrees of force, it will excite different tones of sound; sometimes the blast brings out all the tones in full concert, and sometimes it sinks them to the softest murmurs.

There are different kinds of these instruments; one, invented by the Rev. W. Jones, has the strings fixed to a sounding-board, or belly, within a wooden case, and the wind is admitted to them through an horizontal aperture. In this form the instrument is portable, and may be used any where in the open air. The tension of the strings must not be great, as the air, if gentle, has not sufficient power to make them vibrate, and if it blows fresh, the instrument does not sing, but scream. See Harmonics.

ACQUITTAL, in law, is a deliverance or setting free from the suspicion of guilt; as one who is discharged of a felony is said to be acquitted thereof.

Acquittal is either in fact, or in law; in fact, it is where a person, on a verdict of the jury, is found not guilty; in law, it is when two persons are indicted, one as a principal, &c. the other as accessary: here, if the former be discharged, the latter of consequence is acquitted.

ACQUITTANCE, a discharge in writing for a sum of money, witnessing that the party is paid the same.

A man is obliged to give an acquittance on receiving money: and a servant's acquittance for money received for the use of his master shall bind him, provided the servant used to receive his master's rents. An acquittance is a full discharge, and bars all actions, &c.

ACRIDÆ, in entomology, the name by which Linnæus has distinguished the first family of the gryllus, or the cricket, properly so called: the characters of which are, that the head is conical and longer than the thorax, and the antennæ ensiform, or sword-shaped. Of this family there are eight species, none of which are found in Britain. The insects of this family feed on other insects. See Gryllus.

ACROCHORDUS, in natural history, a genus of the class Amphibia, and of the order Serpents. There are but three species, viz. A. javanicus, warted snake, brown, beneath paler; the sides obscurely variegated with whitish. It inhabits Java, chiefly among the pepper plantations; grows sometimes to seven feet long. The warts, by means of a magnifying glass, appear to be convex carinate scales, and the smaller ones are furnished with two smaller prominences, one each side the larger. Head somewhat flattened, hardly wider than the neck, body gradually thicker towards the middle, and suddenly contracting near the tail, which is short, and slightly acuminate. A. dubius, which very nearly resembles the javanicus, except that the head is covered with very minute, rough and warted scales, differing in size alone from those on the other part of the animal. The dubius measures only about three feet in length. A specimen is to be seen in the British Museum. Its native place is not ascertained. A. fasciatus, resembles the dubius so much, that some naturalists suppose them both to be of the same species, and differing only in age and cast of colours. The specimen in the British Museum is about eighteen inches long. See plate Serpentes, fig. 1.

ACRONICHAL, or Achronycal, in astronomy, an appellation given to the rising of a star above the horizon, at sunset; or to its setting when the sun rises. Acronichal is one of the three poetical risings of a star: the other two being called cosmical and helical.

This term is also applied to the superior planets, Saturn, Jupiter, and Mars, when they are come to the meridian of midnight.

ACROSTERMUM, in botany, a genus of the Cryptogamia Fungi class and order; fungus quite simple, nearly erect, emitting the seeds exteriorly from the top. There are four species.

ACROSTICUM, *rusty-back*, *wall-rue*, or *forked-fern*, in botany, a genus of the Cryptogamia Filices; the character of which is, that the fructifications cover the whole inferior surface of the leaf. There are

45 species, distributed into different classes. Few of the species have been introduced into gardens. Those of Europe may be preserved in pots, filled with gravel and lime-rubbish, or planted on walls and artificial rocks; but most of them, being natives of very hot climates, must be planted in pots, and plunged into the bark pit.

ACTÆA, in botany, a genus of plants of the Polyandria Monogynia class and order. Gen. character: calyx perianth, four-leaved; leaflets roundish, obtuse, concave, caducous; cor. petals four, acuminate at both ends, larger than the calyx; filaments about 30; germ superior ovate; no style; stigma thickish, obliquely depressed; pericarp a berry, oval-globose, smooth, one-furrowed, one celled; seeds very many, semi-orbicular, lying over each other in two rows. There are four species, viz. the spicata; racemosa; japonica; and aspera. Of the first there are varieties, of the black-berried herb Christopher, or bane-berry, found in the northern parts of England; the Christopher, with white berries, a native of America; and that with red berries. The racemosa, or black snake-root, found also in America, of which the root is much used in many disorders, and is supposed to be an antidote against the bite of the rattle-snake, This species is now more properly referred to the genus *Cimifuga*, and is called by Pursh Cimifuga Serpentaria. See CIMIFUGA. The leaves of the A. aspera, being extremely rough, the Chinese use them in polishing their tin ware.

ACTINIA, in natural history, a genus of the Mollusca order of worms; the characters of which are, body oblong, cylindrical, fleshy, contractile, fixed by the base; mouth terminal, expansile, surrounded with numerous cirri, and without any aperture. There are 36 species. These marine animals are viviparous, and have no aperture but the mouth. They feed on shell-fish and other marine animals, which they draw in with their feelers, in a short time rejecting through the same aperture the shells and indigestible parts. They assume various forms, and where the tentacula or feelers are all expanded, have the appearance of full-blown flowers. Many of them are eatable, and some of them very sapid.

ACTINOLITE, in mineralogy, a family, comprehending six species, viz. the actinolite, smaragdite, tremolite, cyanite, syalite, and schalstone. The actinolite occurs chiefly in beds in primitive mountains, and is divided into three sub-species, viz. the asbestos, common and glassy. The asbestos colours greenish grey, mountain green, smelt blue, olive green, yellowish, and liver-brown. Massive, and in capillary crystals. Soft; brittle; specific gravity 2.5 to 2.9. Melts before the blowpipe. The usual colour of the common is leek green, but its specific gravity is between 3.0 and 3.3. The principal colour of the glassy is mountain green, passing to the emerald green. Specific gravity 2.9 to 3.9.

ACTION, in mechanics and physics, is the influence of one body upon another, in generating or destroying its motion.

It is one of the laws of nature, that action and reaction are equal, that is, the resistance of the body moved is always equal to the force communicated to it: or, which is the same thing, the moving body loses as much of its force as it communicates to the body moved.

If a body be urged by equal and contrary actions or pressures, it will remain at rest. But if one of these pressures be greater than its opposite, motion will ensue toward the parts least pressed.

It is to be observed, that the actions of bodies on each other, in a space that is carried uniformly forward, are the same as if the space were at rest; and any powers or motions that act upon all bodies, so as to produce equal velocities in them in the same, or in parallel right lines, have no effect on their mutual actions, or relative motions. Thus the motion of bodies aboard a ship, that is carried steadily and uniformly forward, are performed in the same manner as if the ship was at rest. The motion of the earth round its axis has no effect on the actions of bodies and agents at its surface, but so far as it is not uniform and rectilineal. In general, the actions of bodies upon each other depend not on their *absolute*, but *relative* motion.

ACTION, in law, denotes either the right of demanding, in a legal manner, what is any man's due, or the process brought for the recovering the same.

Actions are either criminal or civil.

Criminal actions are to have judgment of death, as appeals of death, robbery, &c. or only judgment for damage to the injured party, fine to the king, and imprisonment.

Under the head of criminal actions may likewise be ranked penal actions, which lie for some penalty or punishment on the party sued, whether it be corporal or pecuniary.

Also actions upon the statute, brought on breach of any statute, or act of parlia-

ment, by which an action is given that did not lie before; as where a person commits perjury to the prejudice of another, the injured party shall have an action upon the statute. And lastly, popular actions, so called, because any person may bring them on behalf of himself and the crown, by information, &c. for the breach of some penal statute.

Civil actions are divided into real, personal, and mixed.

Real action, is that whereby a man claims a title, lands, tenements, &c. in fee, or for life, and this action is either possessory, or ancestral; possessory, where the lands are a person's own possession or seisin; ancestral, when they were of the possession or seisin of his ancestors.

Personal action, is one brought by one man against another, upon any contract for money or goods, or on account of trespass, or other offence committed; and thereby the debt, goods, chattels, &c. claimed.

Mixt action, one lying as well for the thing demanded as against the person who has it; and on which the thing is recovered, with damages for the wrong sustained; such is an action of waste, sued against a tenant for life, the place wasted being recoverable, with treble damages for the wrong done.

ACTS *of parliament*, statutes, acts, edicts, made by the king, with the advice and consent of the lords spiritual and temporal, and commons, in parliament assembled. An act of parliament is the highest possible authority, and hath power to bind not only every subject, but the king himself, if particularly named therein, and cannot be altered or repealed but by the same authority. Where the common law and the statute law differ, the common law gives place to the statute, and an old statute gives place to a new one. Penal statutes must be construed strictly; thus a statute of Edw. I. having enacted, that those convicted of stealing horses should not have the benefit of clergy, the judges conceived that this did not extend to him that should steal but one horse, and a new act for that purpose was passed in the following year. Statutes against frauds are to be liberally and beneficially expounded. One part of a statute must be construed by another, that the whole may, if possible, stand;—a saving clause totally repugnant to the body of the act. If a statute that repeals another is itself repealed afterwards, the first statute is hereby revived. Acts of parliament derogatory from the power of subsequent parliaments bind not. Acts of parliament, that are impossible to be performed, are of no validity.

ACULEATE, or Aculeated, an appellation given to any thing that has aculei, or prickles: thus fishes are divided into those with aculeated and not aculeated fins.

The same term is applied, in botany, to the stems and branches of those plants that are furnished with prickles, as the rose, the raspberry, and barberry trees. The prickle differs from the thorn, which is another species of armature, or defence, against animals, in being only a prolongation of the cortex or outer bark of the plant, and not connected with nor protruded from the wood. This is apparent, from the ease with which such prickles are detached from the stem with the bark, while the other and more rigid species of weapon, being an expansion of the ligneous body, cannot be detached, without rendering and tearing the substance of the wood. Prickles are either straight, as in the solanum indicum; or bent inwards, as in the mimosa cineraria; or bent outwards; or downy, that is, covered with a sort of wool. See Tomentum.

ACUMINATE, in natural history, a term applied to fishes whose tails end in a sharp point.

AD, a Latin preposition, expressing the relation of one thing to another.

It is frequently prefixed to other words: thus,

Ad *hominem*, among logicians, an argument drawn from the professed belief or principles of those with whom we argue.

Ad *valorem*, among the officers of the king's revenue, a term used for such duties, or customs, as are paid according to the value of the goods sworn to by the owner.

ADAGIO, in music, signifies the second degree of music from slow to quick. It is applied to music not only meant to be performed in slow time, but also with grace and embellishment.

ADAMANTINE *spar*, in mineralogy, one of the species of the ruby family, found only in China. Colour dark, hair brown. Massive, crystallized in six-sided prisms, and six-sided pyramids, having their apex truncated. Specific gravity 3.98. See Ruby.

ADAMBEA, in botany, a genus of the Polyandria Monogynia class and order, of which there is but a single species, which grows on the coast of Malabar, in sandy and stony places; rises to about seven feet, and sends forth branches, which

are terminated by panicles of fine purple flowers, large, and resembling roses.

ADANSONIA, in botany, a genus of the Monadelphia order, and Polyandria class, named after Michael Adanson, an indefatigable French naturalist. The A. digitata, Ethiopean sour-gourd, or monkies' bread, called also abavo, is the only species known of this genus.

ADDER. See COLUBER.

ADDITION, in arithmetic, the first of the four fundamental rules of that art, whereby we find a sum equal to several smaller ones. See ALGEBRA and ARITHMETIC.

ADDITIONS, in law, denote all manner of designations given to a man, over and above his proper name and surname, to shew of what estate, degree, mystery, place of abode, &c. he is.

Additions of degree are the same with titles of honour or dignity, as knight, lord, earl, duke, &c.

Additions of estate are yeoman, gentleman, esquire, and the like.

Additions of mystery, or trade, are, carpenter, mason, painter, engraver, and the like.

Additions of place, or residence, are, London, Edinburgh, Bristol, York, Glasgow, Aberdeen, &c.

These additions were ordained, to prevent one man's being grieved, or molested, for another; and that every person might be certainly known, so as to bear his own burden.

If a man is of different degrees, as duke, earl, &c. he shall have the most worthy; and the title of knight, or baronet, is part of the party's name, and therefore ought to be rightly used; whereas that of esquire, or gentleman, being as people please to call them, may be used, or not, or varied at pleasure.

A Peer of Ireland is no addition of honour here; nay, the law-addition to the children of British noblemen is only that of esquire, commonly called lord.

Writs without the proper additions, if excepted to, shall abate; only, where the process of outlawry doth not lie, additions are not necessary. The addition of a parish, not in any city, must mention the county, otherwise it is not good.

ADDITION, in heraldry, something added to a coat of arms, as a mark of honour; and therefore directly opposite to abatement.

ADDUCTOR, in anatomy, a general name for all such muscles as serve to draw one part of the body towards another. See ANATOMY.

ADELIA, in botany, a genus of the Dioecia Gynandria class and order. Male: calyx three-parted; no corolla; stamina numerous; united at the base. Female: calyx five-parted; no corolla; styles three, lacerated. Capsule three-grained.

ADENANTHERA, in botany, a genus of the Decandria Monogynia class of plants, the calyx of which is a single-leaved perianthium, very small, and cut into five segments: the corolla consists of five lanceolated bell-shaped petals; the fruit is a long membranaceous compressed pod, containing several round seeds. There are three species: A. paronina, which is one of the largest trees in the East Indies. Its duration is 200 years, and its timber is much used on account of its solidity: the powder of the leaves is used in their religious ceremonies; the seeds are eaten, and also valued as weights, being each of them four grains. This species must be raised on a hot-bed from seeds. It has never flowered in England: it is of very slow growth. The other species, viz. the A. falcata, and A. scandens, have not been cultivated in this country.

ADENIA, in botany, a genus of the Hexandria Monogynia class and order, that grows in Arabia. There is but one species, which is mentioned by Forskal, in his Flor. Ægypt. He says, that the powder of the young branches mixed in any kind of liquor is a strong poison, and that the capparis spinosa is an antidote to it.

ADFECTED *equations*, in algebra, those wherein the unknown quantity is found in two or more different powers: such is $x^3-ax^2+bx=a^2b$.

ADHESION, in philosophy and chemistry, is a term generally made use of to express the property which certain bodies have, of attracting to themselves other bodies, or the force by which they adhere together: thus, water adheres to the finger, mercury to gold, &c. Hence arises an important distinction between two words, that in a loose and popular sense are often comfounded. Adhesion, denotes an union to a certain point between two dissimilar substances; and cohesion, that which retains together the component particles of the same mass. See COHESION.

Adhesion may take place either between two solids, as two hemispheres of glass, which, according to an experiment of Desaguliers, adhere to each other with a force equal to 19 ounces on a surface of contact one-tenth of an inch in diameter; or between solids and fluids, as the sus-

pension of water in capillary tubes; or, lastly, between two fluids, as oil and water. About the same time Mr. Hauksbee proved, experimentally, the error which Bernoulli had fallen into, in attributing the adhesion of surfaces and capillary attraction to the pressure of the atmosphere. Nevertheless, in 1772, M. M. La Grange and Cigna, taking for granted a natural repulsion between water and oily substances, imagined, if there was an adhesion between water and oil, or tallow, that it must be occasioned by a cause different from attraction: and having ascertained the reality of the adhesion, they concluded that it was occasioned by the pressure of the air, and that Dr. Taylor's method was not well founded.

Such was the state of opinions on the subject, when, in 1773, Guyton Morveau made his celebrated experiments on adhesion, in presence of the Dijon Academy, demonstrating, as indeed Hauksbee had done before him, not only that water ascends between two parallel plates of tallow, separated from each other 1.8 of a line, but also that the atmospheric pressure is not in the least degree the cause of the phenomenon, which is solely attributable to attraction; in proof of this, a polished disk of glass, 30 lines in diameter, was suspended to the arm of a balance, and brought into contact with the surface of mercury: the counterpoise required to separate it was equivalent to 9 gros and a few grains, and upon moving the apparatus into the receiver of an air-pump, and forming as perfect a vacuum as possible, precisely the same counterpoise was required as before.

In the prosecution of his inquiries on this subject, he observed, that the same disk of glass, which, when in contact with pure water, adhered to it with a force equal to 258 grains, required a counterpoise of only 210, in order to separate it from a solution of potash, notwithstanding the superior density of this last. This inequality of effects on equal diameters, and in an inverse order to that of the respective specific gravities of the two fluids, appeared not only to be decisive in favour of Dr. Taylor's method, but to encourage the hope of applying it to the calculation of chemical affinities.

In order to verify this proposition, plates of the different metals in their highest state of purity were procured, perfectly round, an inch in diameter, of the same thickness, well polished, and furnished with a small ring in the centre of each, so as to keep them suspended precisely parallel to the plane of the horizon. Each of these plates was in turn suspended to the arm of an assay balance, and exactly counterpoised by weights placed in the scale attached to the opposite arm; the plate, thus balanced, was applied to the surface of some mercury in a cup, about two lines beneath it, by sliding the plate over the mercury, as in the silvering of mirrors, so as to exclude every bubble of air; weights were then successively added, till the adhesion between the plate and the mercury was broken. Fresh mercury was used for each experiment. The following is the table of results:

Gold adheres to mercury with a force equal to	446 grains.
Silver	429
Tin	418
Lead	397
Bismuth	372
Zinc	204
Copper	142
Antimony (regulus)	126
Iron	115
Cobalt	8

The striking differences in the above table shew that the pressure of the atmosphere has no share in them, since in this respect the circumstances of each were precisely similar; nor do they depend on the respective specific gravities; for if so, silver should rank after lead, cobalt before zinc, and iron before tin.—The only order which agrees with the above is that of the chemical affinity of these metals, or the respective degrees of their solubility in mercury. It is highly probable, therefore, that at least the principal part of the adhesive force thus found by experiment is owing to chemical affinity; and that the above numerical series, 446, 429, 418, 397, &c. is an approximation towards the ratio of the relative affinities of gold, silver, tin, lead, &c. for mercury.

ADIANTHUM, *Maidenhair*, in botany, the name of a genus of plants of the Cryptogamia Filices class and order, the characters of which are, that the fructifications are collected in oval spots at the ends of the leaves, which are folded back. There are forty-four species, of which one only belongs to Great Britain, viz. the A. capillus veneris, which is found rarely in Scotland and Wales, on rocks and moist walls, and which is a native of the south of Europe and the Levant. From this the syrup of capillaire is made. Another species, the Adianthum pedatum, was formerly esteemed as a valuable article

of the Materia Medica. It has, however, fallen into disrepute.

ADIPOCIRE, is a term formed of adeps, fat, and cera, wax, and denotes a substance, the nature and origin of which are thus explained. The changes which animal matter undergoes in its progress towards total decomposition have been, for many obvious reasons, but little attended to. But an opportunity of this kind was offered at Paris in 1786 and 1787, when the old burial ground of the Innòcens was laid out for building upon, in consequence of which, the surface soil, and the animal remains contained therein, were removed. This cemetry having been for ages appropriated to the reception of the dead, in one of the most populous districts of Paris, was eminently well calculated to exhibit the various processes of animal decomposition; another favourable circumstance was, that it contained several of those large pits (fosses communes) in which the bodies of the poor are deposited by hundreds. These pits are cavities 30 feet deep, with an area of 20 feet square, in which the shells containing the bodies are closely packed in rows over each other, without any intermediate earth, and with only a slight superficial covering of soil, not more than a foot thick: each pit contained from 1200 to 1500 bodies, and may be considered as a mass of animal matter of the dimensions above mentioned. M. M. Fourcroy and Thouret were present at the opening of several of these receptacles; and it is from a memoir by the former of these, that the principal part of this article is composed. The first pit that was examined had been filled and closed up fifteen years before; on opening some of the coffins (for the wood was still quite sound, only tinged of a yellow colour) the bodies were found within shrunk, so as to leave a considerable vacant space in the upper part of the coffin, and flattened, as if they had been subject to a strong compression; the linen which covered them adhered firmly, and upon being removed, presented to view only irregular masses of a soft, ductile, greyish-white matter, apparently intermediate between fat and wax; the bones were enveloped in this, and were found to be very brittle. The bodies, thus changed, being but little offensive to the smell, a great number were dug up and minutely examined: in some this alteration had, as yet, only partially taken place, the remains of muscular fibres being still visible; but where the conversion had been complete, the bones throughout the whole body were found covered with this grey substance, generally soft and ductile, sometimes dry, but always readily separating into porous cavernous fragments, without the slightest trace of muscles, membranes, vessels, tendons, or nerves: the ligaments of the articulations had been in like manner changed; the connexion between the bones was destroyed, and these last had become so yielding, that the grave-diggers, in order to remove the bodies more conveniently, rolled each upon itself from head to heels, without any difficulty. According to the testimony of these men, to whom the facts just mentioned had been long familiar, this conversion of animal matter is never observed in those bodies that are interred singly, but always takes place in the fosses communes: to effect this change, nearly three years are required. The soapy matter of latest formation is soft, very ductile, light, and spongy, and contains water; in 30 or 40 years it becomes much drier, more brittle, and assumes the appearance of dense laminæ, and where the surrounding earth has been drier than usual, it is sometimes semitransparent, of a granulated texture, brittle, and bears a considerable resemblance to wax. Animal matter, having once passed into this stage of decomposition, appears to resist for a long time any further alteration: some of these pits that had been closed above 40 years were, upon examination, found to be little else than a solid mass of soapy matter; nor is it yet ascertained, how long in common circumstances it would continue unchanged, the burial ground of the Innòcens being so small, in comparison to the population of the district, as to require each pit in 30 or 40 years to be emptied of its contents, in order to receive a new succession of bodies: it appears, however, that the ulterior changes depend in a great measure on the quantity of moisture draining through the mass. From the history of this singular substance, we proceed to an examination of its chemical properties. It was first, however, purified by gently heating in an earthen vessel, till it became of a pasty consistence, and then rubbed through a fine hair sieve, by which means the hair, small bones, and remains of the muscular fibre, were separated with tolerable exactness. In this state, being exposed in an earthen vessel to the naked fire, it readily became soft, but did not liquify without consider-

able difficulty, rather frying as a piece of soap would do, and disengaging at the same time ammoniacal vapours. Four pounds being put into a glass retort, and submitted to slow distillation in a water bath, afforded in the space of three weeks eight ounces of a clear watery fluid, with a fœtid odour, turning syrup of violets green, and manifestly containing ammonia in solution; the soapy matter remaining in the retort had acquired a greater consistence, was become less fusible, of a deeper brown colour, and, upon cooling, was evidently drier than before, though not admitting of being broken. Eight ounces of soapy matter, white and purified, were mixed with an equal weight of powdered quick lime; on the addition of a little water, the mass heated, swelled, and disengaged a very strongly ammoniacal vapour, accompanied by a peculiar putrescent smell; a sufficiency of water being then added, to bring the whole to the state of an emulsion, it was heated to ebullition, much ammoniacal vapour escaping at the same time; the liquor being thrown on a filter, passed perfectly clear and colourless, and appeared to be only lime-water, with a very small quantity of soap in solution: the matter remaining on the filter, being well washed, was beaten up with water, but shewed no tendency to unite with it, subsiding after a time in the form of a white mass; this, by drying for a few days in the open air, became grey, and much reduced in volume: it was then mixed with diluted muriatic acid, which immediately decomposed it, and a number of white clots rose to the surface of the liquor. This last being obtained clear by filtration, yielded crystals of muriat of lime, and a slight trace of phosphoric salt; the white clots being washed and dried, and afterwards melted in a water bath, cooled into a dry, combustible, oily matter, brittle, waxy, crystallizable, and perfectly insoluble in water, to which the name of adipocire has been appropriated. From this series of experiments with lime, it appears that the soapy matter is a true ammoniacal soap, with a base of adipocire, to which lime has a stronger affinity than ammonia; but which last composition is again in its turn decomposed by all the acids, leaving the adipocire in a state of purity. Potash and soda produce effects perfectly analogous to these of lime. To the foregoing experiments of Fourcroy, a few facts have since been added by Dr. Gibbes. The receptacle at Oxford for those bodies, which have been used by the anatomical professor there for his demonstrations, is a hole dug in the ground to the depth of thirteen or fourteen feet, and a little stream is turned through it, in order to remove all offensive smell: the flesh contained in this was found, on examination, to be quite white, and for the most part changed into the soapy matter above mentioned. From this hint, pieces of lean beef were enclosed in a perforated box, and placed in running water, and at the end of a month were found converted into a mass of fatty matter; this change was observed to take place much sooner, and more completely, in running than in stagnant water: in order to get rid of the fœtid smell, nitrous acid was had recourse to, which immediately had the desired effect; a waxy smell was perceived, and by melting the matter it was obtained nearly pure; the yellow colour, which had been given to it by the nitrous acid, was wholly discharged by the oxymuriatic acid. A similar conversion of muscular fibre takes place by maceration in very diluted nitrous acid. Dr. Gibbes has not mentioned whether the fatty matter produced by running water is pure adipocire, or ammoniacal soap: it appears probable, however, that it is in the former state; where nitrous acid is the menstruum employed, it is obviously impossible that the adipocire should be combined with an alkali.

ADIT *of a Mine*, the hole or aperture whereby it is entered and dug, and by which the water and ores are carried away; it is distinguished from the air-shaft. The adit is usually made on the side of a hill, towards the bottom, about four or six feet high, and eight wide, in form of an arch; sometimes cut into the rock, and sometimes supported with timber, so conducted, as that the sole or bottom of the adit may answer to the bottom of the shaft, only somewhat lower, that the water may have a sufficient current to pass away without the use of the pump.

ADJUTAGE, or Ajutage, in hydraulics, the tube fitted to the mouth of a pipe through which a fountain plays. See Hydraulics.

ADJUTANT, in the military art, an officer whose business is to assist the major, and therefore sometimes called the aid-major.

Adjutant-*general*, an officer of distinction, who assists the general in his laborious duty: he forms the several de-

tails of the duty of the army with the brigade majors, and keeps an account of the state of each brigade and regiment. In the day of battle he sees the infantry drawn up, after which he places himself by the side of the general, to receive orders. In a siege he visits the several posts, gives and signs all orders, and has a serjeant from each brigade to carry any orders which he may have to send.

ADMEASUREMENT, in law, a writ for adjusting the shares of something to be divided. Thus, admeasurement of dower takes place, when the widow of the deceased claims more as her dower than what of right belongs to her. And admeasurement of pasture may be obtained, when any of the persons who have right in a common pasture puts more cattle to feed on it than he ought.

ADMINISTRATOR, in law, the person to whom the goods, effects, or estate of one who died intestate are entrusted; for which he is to be accountable when required.

The bishop of the diocese, where the party dies, is regularly to grant administration; but if the intestate has goods in several dioceses, administration must be granted by the archbishop in the prerogative court. The persons to whom administration is granted are, a husband, wife, children, whether sons or daughters, the father or mother, brother or sister, and, in general, to the next of kin, as uncle, aunt, cousin; then to a creditor.

An action lies for and against an administrator, as for and against an executor; only that he is accountable no farther than to the value of the goods.

ADMIRAL, in maritime affairs, a great officer, who commands the naval forces of a kingdom or state, and decides all maritime causes. For the latter purposes a commission has been instituted in England, who, by a statute of W. and M. have the same authority as the Lord High Admiral. The admirals of England are merely naval commanders. Every other business relative to the navy at large is directed by the Lords Commissioners of the Admiralty. See PRECEDENCE, ADMIRALTY COURT, &c.

ADMIRALTY, properly signifies the office of Lord High Admiral, whether discharged by one or several joint commissioners, called Lords of the Admirslty.

ADMIRALTY-*Court*, or Court of Admiralty, in the British polity, a sovereign court held by the Lord High Admiral, or the Commissioners of the Admiralty.

This court has cognizance in all maritime affairs, civil as well as criminal. All crimes committed on the high-seas, or in great rivers, beneath the bridge next the sea, are cognizable only in this court; which, by statute, is obliged to try the same by judge and jury. But in civil causes it is otherwise, these being all determined according to the civil law; the reason whereof is, because the sea is without the jurisdiction of the common law.

In case any person be sued in the admiralty-court, contrary to the statutes, he may have the writ of supersedeas, to stop farther proceedings, and also an action for double damages against the person suing.

Subordinate to this court, there is another of equity, called Court-merchant; wherein all causes between merchants are decided, agreeable to the rules of the civil law.

ADOLIA, in botany, a genus of plants found among the trees at Malabar, which bear a near relation to the rahmnus.—There are two species, viz. A. alba, with white flowers, which grows to the height of seven or eight feet, and bears fruit twice a year: the berries, when ripe, are of a purplish black colour: and A. rubra, with red flowers: but the berries, when ripe, are of an orange colour, and of an acid taste.

ADONIS, *Pheasant's Eye*, or *Red Maiths*, in botany, a genus of the Polyandria Polygynia class of plants, the calyx of which is a perianthium, composed of five obtuse, hollow, somewhat coloured and deciduous leaves; the corolla consists of five oblong obtuse beautiful petals, and sometimes there are more than five; there is no pericarpium; the receptacle is oblong, spicated, and holds five series of seeds; the seeds are numerous, irregular, and angular, gibbous at the base, and their apex reflex and prominent.—There are six species, viz. the A. æstivalis, or tall, which is a native of the southern countries of Europe, where it grows among corn: the A. autumnalis, or common, which are found in Kent, near the Medway, in fields sown with wheat: the flowers are brought in great quantities to London, where they are sold under the name of Red Morocco: this is annual, and flowers from May to October: A. vernalis, or spring adonis, is found in Switzerland, Prussia, and some parts of Germany: A. apennina is found wild in Siberia: A. vescatoria, or blister adonis,

and the A. capensis, are used by the Africans for raising blisters. To these have been added two other species, viz. the miniata and the flammea.

ADOXA, in botany, a genus of the Octandria Tetragynia class of plants, the corolla of which is plain, and consists of a single petal, divided into four oval acute segments, longer than the cup; the fruit is a globose berry, situated between the calyx and corolla; the calyx adheres to its under part; the berry is umbilicated, and contains four cells; the seeds are single and compressed. There is but a single species, viz. the A. moschatellina, bulbous fumitory, which grows naturally in shady places and woods, as in Hampstead and Charlton woods; it is perennial; flowers in April and May. The leaves soon after decay, and the flowers smell like musk, on which account it has sometimes been called musk-crowfoot.

AD QUOD DAMNUM, in law, a writ which ought to be issued before the king grants certain liberties, as a fair, market, or the like; ordering the sheriff to inquire by the country what damage such a grant is like to be attended with.

ADRIFT, in naval affairs, the state of a vessel broken loose from her moorings, and driven to and fro by the winds or waves.

ADVERB, *adverbium*, in grammar, a word joined to verbs, expressing the manner, time, &c. of an action; thus, in the phrase, *it is conducive to health to rise early;* the word *early* is an adverb; and so of others.

ADVERSARIA, among the ancients, was a book of accounts, not unlike our journals or day books.

Adversaria is more particularly used, among men of letters, for a kind of common-place book, wherein they enter whatever occurs to them worthy of notice, whether in reading or conversation, in the order in which it occurs: a method which Morbof prefers to that of digesting them under certain heads.

ADVOCATE, *Lord*, one of the officers of state in Scotland, who pleads in all causes of the crown, or wherein the king is concerned.

The lord advocate sometimes happens to be one of the lords of session; in which case, he only pleads in the king's causes.

ADVOWSON, in law, is the right of patronage, or presenting to a vacant benefice.

Advowsons are either appendant, or in gross. Appendant advowsons are those which depend on a manor, or lands, and pass as appurtenances of the same: whereas advowson in gross is a right of presentation subsisting by itself, belonging to a person, and not to lands.

In either case, advowsons are no less the property of the patrons than their landed estate: accordingly, they may be granted away by deed or will, and are assets in the hands of executors. However, Papists and Jews, seized of any advowsons, are disabled from presenting; the right of presentation being in this case transferred to the chancellors of the universities, or the bishop of the diocese.

Advowsons are also presentative, collative, or donative. Presentative, where the patron hath a right of presentation to the bishop or ordinary; collative, where the bishop is patron; and donative, where the king, or any subject. This license founds a church or chapel, and ordains that it shall be merely in the gift of the patron.

ADZE, a cutting tool, of the axe kind, having its blade thin and arching, and its edge at right angle to the handle; chiefly used for taking thin chips off timber, &c. It is used by carpenters, but more frequently by coopers.

ÆCIDIUM, in botany, a genus of the Criptogamia Fungi class and order. Its characters are, that it has a membranaceous sheath, smooth on both sides, and full of naked separate sides. There are 18 species, of which several are found on the leaves of other plants, and one of them is known to agriculturalists by the name of *red gum.* This species usually grows upon the inside of the glumes of the calyx, and of the exterior valvule of the corolla, under their epidermes, which, when the plant is ripe, bursts, and emits a powder of a bright orange colour.—Other species grow on decaying wood and mosses, and in the leaves of tussilago, farfara, &c.

ÆGICERAS, a genus of the Pentandria Monogynia class and order: calyx five-cleft; petals five; capsule curved; one-celled; one-valved; one-seeded; two species found in the Moluccas.

ÆGILOPS, *goat's face*, in botany, a genus of the Triandria Digynia class and order, and of the natural order of grasses: the characters are, that the hermaphrodite calyx is a large bivalvular glume, sustaining three flowers; the valves are ovate, and streaked with various awns: the nectary two-leaved, with very small

leaflets: the stamina have three capillary filaments with oblong anthers; the pistillum is a turbinate germen; no pericardium; the seeds are oblong, convex on one side, grooved on the other, with the inner valve of the corolla adhering to it, and not opening. There are six species.

ÆGINETA, in botany, a genus of the Didynamia Angiospermia class and order: calyx one-leafed, spathaceous; corolla campanulate, two-lipped; capsule many celled: one species, viz. the Æ. Indica, found at Malabar.

ÆGIPHILA, *goat's-friend*, a genus of the Tetrandria Monogynia class and order, and the natural order of Vitices: the calyx is a one-leafed permanent perianthium; the corolla is one-petalled, and longer than the calyx; the stamina are capillary filaments, inserted into the mouth of the tube; the pistillum is a roundish superior germ, style capillary, deeply bifid, and stigmas simple; the pericarpium is a roundish two-celled berry, surrounded with a permanent calyx; and the seed is either in pairs or solitary. There are seven species, natives of the W. Indies, chiefly of Jamaica.

ÆGLE, in botany, a genus of the Polyandria Monogynia class and order: calyx five-lobed; petals five; berry globular, many celled, with numerous seeds in each. One species, viz. the marmelos, a tree with thorny branches; fruit delicious to the taste, and exquisitely fragrant; seeds imbedded in an extremely tenaceous transparent gluten.

ÆGOPODUM, in botany, a genus of the Pentandria Digynia class of plants; the general corolla whereof is uniform; the single flowers consist each of five, oval, concave, and nearly equal petals; the fruit is naked, ovato-oblong, striated, and separable into two parts; the seeds are two, ovato-oblong, and striated, convex on one side, and plain on the other. There is but one species, viz. Æ. podagraria, gout-weed, which is a perennial, creeping weed, with white flowers, that appear in May or June. It has been used in cases of gout, whence it derives its name. It is boiled for greens, and eaten in Sweden; cows, sheep, and goats, eat it. It is found among rubbish in shady places, and in hedges.

ÆGOPRICON, in botany, a genus of the Monandria Trigynia class and order: the male flowers are small, in an ovate ament; their calyx one-leafed; no corolla, the stamina of one filament longer than the calyx, with an ovate anther; the female flowers are on the same plant, and solitary; the calyx and corolla are the same as the male; the pistillum has an ovate superior germ, three divaricate styles, with simple permanent stigmas; the pericardium is a globular berry; the seeds are solitary, and angular on one side. There is but one species, viz. Æ. betulinum, which is a tree very much branched, with wrinkled bark and alternate leaves resembling those of the myrtle.

ÆOLIPILE, a hollow metalline ball, in which is inserted a slender neck or pipe; from whence, after the vessel has been filled with water, and heated, issues a blast of wind with great vehemence.

Great care should be taken, that the aperture of the pipe be not stopped when the instrument is put on the fire, otherwise the æolipile will burst with a vast explosion, and may occasion no little mischief. Dr. Plot gives an instance, where the æolipile is actually used to blow the fire; the lord of the manor of Effington is bound, by his tenure, to drive a goose every New-year's day three times round the hall of the lord of Hilton, while Jack of Hilton (a brazen figure having the structure of an æolipile) blows the fire. In Italy, it is said, that the ælopile is commonly made use of to cure smoky chimneys; for being hung over the fire, the blast arising from it carries up the loitering smoke along with it.

An æolipile of great antiquity, made of brass, was lately dug up in the site of the Basingstoke canal, and presented to the Antiquarian Society in London. It is not globular, with a bent tube, but in the form of a grotesque human figure, and the blast proceeds from the mouth.

ÆOLUS'S *harp*, or Eolian *harp*, a musical instrument, so named from its producing an agreeable harmony merely by the action of the wind. See Acoustics.

ÆRA, a fixed point of time, from which any number of years is begun to be reckoned. See Chronology.

AEROSTATION, in the modern application of the term, signifies the art of navigation through the air, both in its principles and practice. Hence also the machines which are employed for this purpose are called aerostats, or aerostatic machines; and on account of their round figure, air balloons.

The fundamental principles of this art have been long and generally known; although the application of them to practice seems to be altogether a modern discovery. It will be sufficient, therefore, to observe, in this place, that any body,

which is specifically, or bulk for bulk, lighter than the atmospheric air encompassing the earth, will be buoyed up by it, and ascend; but as the density of the atmosphere decreases, on account of the diminished pressure of the superincumbent air, and the elastic property which it possesses at different elevations above the earth, this body can rise only to a height, in which the surrounding air will be of the same specific gravity with itself. In this situation it will either float, or be driven in the direction of the wind or current of air, to which it is exposed. An air-balloon is a body of this kind, the whole mass of which, including its covering and contents, and the several weights annexed to it, is of less specific gravity than that of the air in which it rises. Heat is well known to rarefy and expand, and consequently to lessen the specific gravity of the air to which it is applied; and the diminution of its weight is proportional to the heat. One degree of heat, according to the scale of Fahrenheit's thermometer, seems to expand the air about one four-hundredth part; and about 400, or rather 435, degrees of heat will just double the bulk of a quantity of air. If, therefore, the air inclosed in any kind of covering be heated, and consequently dilated to such a degree, as that the excess of the weight of an equal bulk of common air, above the weight of the heated air, is greater than the weight of the covering and its appendages, this whole mass will ascend in the atmosphere, till, by the cooling and condensation of the included air, or the diminished density of the surrounding air, it becomes of the same specific gravity with the air in which it floats; and without renewed heat it will gradually descend. If, instead of heating common air inclosed in any covering, and thus diminishing its weight, the covering be filled with an elastic fluid, lighter than atmospheric air, so that the excess of the weight of an equal bulk of the latter, above that of the inclosed elastic fluid, be greater than the weight of the covering and its appendages, the whole mass will, in this case, ascend in the atmosphere, and continue to rise, till it attains a height at which the surrounding air is of the same specific gravity with itself. Inflammable air, or, as it is called, hydrogen gas, is a fluid of this kind. For the knowledge of many of its properties we are indebted to Mr. Henry Cavendish, who discovered, that if common air is eight hundred times lighter than water, inflammable air is seven times lighter than common air; but if common air is eight hundred and fifty times lighter than water, then inflammable air is 10.8 times lighter than common air. The construction of air-balloons depends upon the principles above stated; and they are of two kinds, as one or the other of the preceding methods of preparing them is adopted.

In the various schemes that have been proposed for navigating through the air, some have had recourse to artificial wings, which, being constructed like those of birds, and annexed to the human body, might bear it up, and by their motion, produced either by mechanical springs, or muscular exertion, effect its progress in any direction at pleasure. This is one of the methods of artificial flying suggested by Bishop Wilkins, in the seventh chapter of his "Dedalus, or Treatise on Mechanical Motions;" but the success of it is doubtful, and experiments made in this way have been few and unsatisfactory. Borelli, having compared the power of the muscles which act on the wings of a bird with that of the muscles of the breast and arms of a man, finds the latter altogether insufficient to produce, by means of any wings, that motion against the air, which is necessary to raise a man in the atmosphere. Soon after Mr. Cavendish's discovery of the specific gravity of inflammable air, it occurred to the ingenious Dr. Black, of Edinburgh, that if a bladder, sufficiently light and thin, were filled with this air, it would form a mass lighter than the same bulk of atmospheric air, and rise in it. This thought was suggested in his lectures in 1767 or 1768; and he proposed, by means of the alantois of a calf, to try the experiment. Other employments, however, prevented the execution of his design. The possibility of constructing a vessel, which, when filled with inflammable air, would ascend in the atmosphere, had occurred also to Mr. Cavallo, about the same time; and to him belongs the honour of having first made experiments on this subject, in the beginning of the year 1782, of which an account was read to the Royal Society, on the 20th of June in that year. He tried bladders; but the thinnest of these, however, scraped and cleaned, were too heavy. In using China paper, he found that the inflammable air passed through its pores, like water through a sieve; and having failed of success by blowing this air into a thick solution of gum, thick varnishes and oil-paint, he was under a necessity of being satisfied with soap-bubbles, which being inflated with inflammable air, by dipping

the end of a small glass tube, connected with a bladder containing air, into a thick solution of soap, and gently compressing the bladder, ascended rapidly in the atmosphere; and these were the first sort of inflammable air-balloons that were ever made. For balloons formed on a larger scale, and on the principle of rarefied air, we must direct our attention to France, where the two brothers, Stephen and Joseph Montgolfier, paper-manufacturers at Annonay, about 36 miles from Lyons, distinguished themselves, by exhibiting the first of those aerostatic machines, which have since excited so much attention and astonishment. The first idea of such a machine was suggested to them by the natural ascent of the smoke and clouds in the atmosphere; and the first experiment was made at Avignon, by Stephen, the eldest of the two brothers, towards the middle of November 1782. Having prepared a bag of fine silk, in the shape of a parallelopipedon, and in capacity about 40 cubic feet, he applied to its aperture burning paper, which rarefied the air, and thus formed a kind of cloud in the bag, and when it became sufficiently expanded, it ascended rapidly to the ceiling. Soon afterwards the experiment was repeated by the two brothers at Annonay in the open air, when the machine ascended to the height of about seventy feet. Encouraged by their success, they constructed a machine, the capacity of which was about 650 cubic feet, which, in the experiment, broke the ropes that confined it, and, after ascending rapidly to the height of about 600 feet, fell on the adjoining ground. With another machine, 35 feet in diameter, they repeated the experiment in April 1783, when, breaking loose from its confinement, it rose to the height of above 1000 feet, and being carried by the wind, it fell at the distance of about three quarters of a mile from the place where it ascended. The capacity of this machine was equal to about 23,430 cubic feet: and when inflated, it measured 117 English feet in circumference. The covering of it was formed of linen lined with paper, its shape was nearly spherical, and its aperture was fixed to a wooden frame about 16 feet in surface. When filled with vapour, which was conjectured to be about half as heavy as common air, it was capable of lifting up about 490 pounds, besides its own weight, which, together with that of the wooden frame, was equal to 500 pounds. With this machine the next experiment was performed at Annonay, on the 5th of June 1783, before a great multitude of spectators. The flaccic bag was suspended on a pole 35 feet high; straw and chopped wool were burnt under the opening at the bottom; the vapour, or rather smoke, soon inflated the bag, so as to distend it in all its parts; and this immense mass ascended in the air with such a velocity, that in less than ten minutes it reached the height of about 6000 feet. A breeze carried it in an horizontal direction to the distance of 7668 feet; and it then fell gently on the ground. M. Montgolfier attributed the ascent of the machine, not to the rarefaction of the heated air, which is the true cause, but to a certain gas or aeriform fluid, specifically lighter than common air, which was supposed to be disengaged from burning substances, and which has been commonly called Montgolfier's gas, as balloons of this kind have been denominated Montgolfiers. As soon as the news of this experiment reached Paris, the philosophers of the city, conceiving that a new sort of gas, half as heavy as common air, had been discovered by Messrs. Montgolfier; and knowing that the weight of inflammable air was not more than the eighth or tenth part of the weight of common air, justly concluded, that inflammable air would answer the purpose of this experiment better than the gas of Montgolfier, and resolved to make trial of it. A subscription was opened by M. Faujas de St. Fond towards defraying the expense of the experiment. A sufficient sum of money having been soon raised, Messrs. Roberts were appointed to construct the machine; and M. Charles, professor of experimental philosophy, to superintend the work. After surmounting many difficulties in obtaining a sufficient quantity of inflammable air, and finding a substance light enough for the covering, they at length constructed a globe of lutestring, which was rendered impervious to the inclosed air by a varnish of elastic gum, or caoutchouc, dissolved in some kind of spirit or essential oil. The diameter of this globe, which, from its shape, was denominated a balloon, was about thirteen feet, and it had only one aperture, like a bladder, to which a stop-cock was adapted: its weight, when empty, together with that of the stop-cock, was 25 pounds. On the 23d of August 1783, they began to fill the globe with inflammable air; but this being their first attempt, was attended with many hindrances and disappointments. At last, however, it was prepared for exhibition; and on the 27th it was carried to the Champ de Mars, where,

being disengaged from the cords that held it down, it rose before a prodigious concourse of people in less than two minutes to the height of 3123 feet. It then entered a cloud, but soon appeared again; and at last it was lost among other clouds. This balloon, after having floated about three quarters of an hour, fell in a field about 15 miles distant from the place of ascent; where, as we may naturally imagine, it occasioned much astonishment to the peasants. Its fall was owing to a rent, occasioned by the expansion of the inflammable air in that part of the atmosphere to which it ascended. When the balloon went up, its specific gravity was 35 pounds less than that of common air. In consequence of this brilliant experiment, many balloons were made on a small scale; gold-beaters skin was used for the covering; and their size was from 9 to 18 inches in diameter.

Mr. Montgolfier repeated an experiment with a machine of his construction before the commissaries of the Academy of Sciences, on the 11th and 12th of September. This machine was 74 feet high, and about 43 feet in diameter. When distended, it appeared spheroidical. It was made of canvass, covered with paper both within and without, and it weighed 1000 pounds. The operation of filling it with rarefied air, produced by means of the combustion of 50 pounds of dry straw, and 12 pounds of chopped wool, was performed in about nine minutes; and its force of ascension, when inflated, was so great, that it raised eight men who held it some feet from the ground. This machine was so much damaged by the rain, that it was found necessary to prepare another for exhibition before the king and royal family on the 19th. This new machine consisted of cloth, made of linen and cotton thread, and was painted with water colours both within and without. Its height was near 60 feet, and its diameter about 43 feet. Having made the necessary preparations for inflating it, the operation was begun about one o'clock, on the 19th of September, before the king and queen, the court, and all the Parisians who could procure a conveyance to Versailles. In eleven minutes it was sufficiently distended, and the ropes being cut, it ascended, bearing up with it a wicker cage, in which were a sheep, a cock, and a duck. Its power of ascension, or the weight by which it was lighter than an equal bulk of common air, allowing for the cage and animals, was 696 pounds. This balloon rose to the height of about 1440 feet; and being driven by the wind, it descended gradually, and fell gently into a wood, at the distance of 10,200 feet from Versailles. After remaining in the atmosphere eight minutes, the animals in the cage were safely landed. The sheep was found feeding; the cock had received some hurt on one of his wings, probably from a kick of the sheep; the duck was perfectly well. The success of this experiment induced M. Pilatre de Rozier, with a philosophical intrepidity which will be recorded with applause in the history of aerostation, to offer himself as the first adventurer in this aerial navigation. Mr. Montgolfier constructed a new machine for this purpose, in a garden in the Fauxbourg St. Antoine. Its shape was oval; its diameter being about 48 feet, and its height about 74 feet. To the aperture at the bottom was annexed a wicker gallery, about three feet broad, with a ballustrade about three feet high. From the middle of the aperture was suspended by chains, which came down from the sides of the machine, an iron grate, or brazier, in which a fire was lighted for inflating the machine; and port-holes were opened in the gallery, towards the aperture, through which any person, who should venture to ascend, might feed the fire on the grate with fuel, and regulate the dilatation of the inclosed air of the machine at pleasure. The weight of the aerostat was upwards of sixteen hundred pounds. On the fifteenth of October, the fire being lighted, and the machine inflated, M. P. de Rozier placed himself in the gallery, and ascended, to the astonishment of a multitude of spectators, to the height of 84 feet from the ground, and there kept the machine afloat during 4′ 25″, by repeatedly throwing straw and wool upon the fire: the machine then descended gradually and gently, through a medium of increasing density, to the ground; and the intrepid adventurer assured the spectators that he had not experienced the least inconvenience in this aerial excursion. This experiment was repeated on the 17th and on the 19th, when M. P. de Rozier, in his descent, and in order to avoid danger by re-ascending, evinced, to a multitude of observers, that the machine may be made to ascend and descend, at the pleasure of the aeronaut, by merely increasing or diminishing the fire in the grate. The balloon having been hauled down, M. Giraude de Villiette placed himself in the gallery opposite to M. Rozier: and being suffered to ascend, it hovered for about nine minutes over

Paris, in the sight of all its inhabitants, at the height of about 330 feet. In another experiment the Marquis of Arlandes ascended with M. Rozier much in the same manner. In consequence of the report of the preceding experiment, signed by the commissaries of the Academy of Sciences, it was ordered that the annual prize of 600 livres should be given to Messrs. Montgolfier for the year 1783. In the experiments above recited the machine was secured by ropes; but they were soon succeeded by unconfined aerial navigation. Accordingly, the balloon of 74 feet in height, above mentioned, was removed to a royal palace in the Bois de Boulogne; and all things being ready, on the 21st of November, M. P. de Rozier and the Marquis d'Arlandes took their respective posts in the gallery, and at 54 minutes after one the machine was absolutely abandoned to the element, and ascended calmly and majestically in the atmosphere. The aeronauts, having reached the height of about 280 feet, waved their hats to the astonished multitude; but they soon rose too high to be distinguished, and are thought to have soared to an elevation of above 3000 feet. They were at first driven by a north-west wind horizontally over the river Seine and over Paris, taking care to clear the steeples and high buildings by increasing the fire; and in rising met with a current of air, which carried them southward. Having passed the Boulevard, and desisting from supplying the fire with fuel, they descended very gently in a field beyond the New Boulevard, about 9000 yards distant from the palace, having been in the air about 25 minutes. The weight of the whole apparatus, including that of the travellers, was between 1600 and 1700 pounds. Notwithstanding the rapid progress of aerostation in France, we have no authentic account of the aerostatic experiments performed in other countries till about the close of the year 1783. The first experiment of this kind, publicly exhibited in our country, was performed in London, on the 25th of November, by Count Zambeccari, an ingenious Italian, with a balloon of oil silk, 10 feet in diameter, and weighing 11 pounds. It was gilt, in order to render it more beautiful, and more impermeable to the gas. This balloon, three-fourths of which were filled with inflammable air, was launched from the Artillery-Ground, in presence of a vast concourse of spectators, at one o'clock in the afternoon, and at half past three was taken up near Petworth, in Sussex, 48 miles distant from London: so that it travelled at the rate of nearly 20 miles an hour. Its descent was occasioned by a rent, which must have been the effect of the rarefaction of the inflammable air, when the balloon ascended to the lighter parts of the atmosphere.

Aerostatic experiments and aerial voyages became so frequent in the course of the year 1784, that the limits of this article will not allow our particularly recording them. We shall, therefore, mention those which were attended with any peculiar circumstances. Messrs. de Morveau and Bertrand ascended from Dijon, in April, to the height of about 13,000 feet, with an inflammable air balloon: the thermometer was observed to stand at 25 degrees. They were in the air during an hour and 25 minutes, and went to the distance of about eighteen miles. The clouds floated beneath them, and secluded them from the earth; and they jointly repeated the motto inscribed on their aerostat:—"Surgit nunc gallus ad aethera." In May, four ladies and two gentlemen ascended with a Montgolfier at Paris above the highest buildings: the machine was confined by ropes. It was 74 feet high, and 72 in diameter. In a second voyage, performed by Mr. Blanchard from Rouen in May, it was observed, that his wings and oars could not carry him in any other direction than that of the wind. The mercury in the barometer descended as low as 20.57 inches; but on the earth, before he ascended, it stood at 30.16 inches. On the 23d of June, a large aerostat, on the principle of rarefied air, 91½ feet high, and 79 feet in diameter, was elevated by Montgolfier at Versailles, in the presence of the royal family and the King of Sweden. M. Pilatre de Rozier, and M. Proust, ascended with it, and continued for 28 minutes at the height of 11,732 feet, and observed the clouds below them, that reflected to the region which they occupied the rays of the sun; the temperature of the air being 5° below the freezing point; and in three quarters of an hour they travelled to the distance of 36 miles. In consequence of this experiment, the king granted to M. Rozier a pension of 2000 livres. On the 15th of July the Duke of Chatres, the two brothers Roberts, and another person, ascended with an inflammable air balloon, of an oblong form, 55½ feet long, and 34 feet in diameter, from the Park of St. Cloud: the machine remained in the atmosphere about 45 minutes. This machine contained an interior small balloon, filled with common air,

by which means it was proposed to make it ascend or descend without any loss of inflammable air or ballast. The boat was furnished with a helm and oars, intended for guiding it. At the place of departure the barometer stood at 30.12 inches. Three minutes after ascending, the balloon was lost in the clouds, and involved in a dense vapour. An agitation of the air, resembling a whirlwind, alarmed the aerial voyagers, and occasioned several shocks, which prevented their using any of the instruments and contrivances prepared for the direction of the balloon. Other circumstances concurred to increase their danger; and when the mercury, standing in the barometer at 24.36 inches, indicated their height to be about 5100 feet, they found it neceasary to make holes in the bottom for discharging the inflammable air: and having made a rent of between seven and eight feet, they descended very rapidly, and at last came safely to the ground. The first aerial voyage in England was performed in London, on the 15th of September, by Vincent Lunardi, a native of Italy. His balloon was made of oiled silk, painted in alternate stripes of blue and red. Its diameter was 33 feet. From a net which went over about two-thirds of the balloon, descended 45 cords to a hoop hanging below the balloon, and to which the gallery was attached. The balloon had no valve; and its neck, which terminated in the form of a pear, was the aperture through which the inflammable air was introduced, and through which it might be let out. The air for filling the balloon was produced from zinc, by means of diluted vitriolic acid. M. Lunardi departed from the Artillery Ground at two o'clock; and with him were a dog, a cat, and a pigeon. After throwing out some sand to clear the houses, he ascended to a great height. The direction of his motion was at first north-west by west; but as the balloon rose higher, it fell into another current of air, which carried it nearly north. About half after three he descended very near the ground, and landed the cat, which was almost dead with cold: then rising, he prosecuted his voyage. He ascribes his descent to the action of an oar; but as he was under the necessity of throwing out ballast in order to reascend, his descent was probably occasioned by the loss of inflammable air. At ten minutes past four he descended on a meadow, near Ware, in Hertfordshire. The only philosophical instrument which he carried with him was a thermometer, which in the course of his voyage stood as low as 29°, and he observed that the drops of water which collected round the balloon were frozen.

The longest and the most interesting voyage, which was performed about this time, was that of Messrs. Roberts and M. Collin. Hullin, at Paris, on the 19th of September. Their aerostat was filled with inflammable air. Its diameter was 27¾ feet, and its length 46¾ feet, and it was made to float with its longest part parallel to the horizon, with a boat nearly 17 feet long, attached to a net that went over it as far as its middle. To the boat were annexed wings, or oars, in the form of an umbrella. At 12 o'clock they ascended with 450 pounds of ballast, and, after various manœuvres, descended at 40 minutes past six o'clock near Arras, in Artois, having still 200 pounds of their ballast remaining in the boat. Having risen about 1400 feet, they perceived stormy clouds, which they endeavoured to avoid; but the current of air was uniform from the height of 600 to 4200 feet. The barometer on the coast of the sea was 29.61 inches, and sunk to 23.94 inches. They found that, by working with their oars, they accelerated their course. In the prosecution of their voyage, which was 150 miles, they heard two claps of thunder; and the cold occasioned by the approach of stormy clouds made the thermometer fall from 77° to 59°, and condensed the inflammable air in the balloon, so as to make it descend very low. From some experiments they concluded, that they were able by the use of two oars to deviate from the direction of the wind about 22°. But this experiment requires repetition, in order to ascertain with accuracy the effect here ascribed to oars. The second aerial voyage in England was performed by Mr. Blanchard and Mr. Sheldon, professor of anatomy to the Royal Academy, the first Englishman who ascended with an aerostatic machine. This experiment was performed at Chelsea, on the 16th of October. The wings used on this occasion seemed to have produced no deviation in the machine's track from the direction of the wind. Mr. Blanchard, having landed his friend about the distance of 14 miles from Chelsea, proceeded alone, with different currents, and ascended so high as to experience great difficulty of breathing; a pigeon, also, which flew away from the boat, laboured some time with its wings, in order to sustain itself in the rarified air, and after wandering for a good while,

returned, and rested on one side of the boat. Mr. Blanchard, perceiving the sea before him, descended near Rumsey, about 75 miles from London, having travelled at the rate of nearly 20 miles an hour.

On the 12th of October, Mr. Sadler, of Oxford, made a voyage of 14 miles from that place in 17 minutes, with an inflammable air balloon of his own contrivance and construction. The fate of M. P. de Rozier, the first aerial navigator, and of his companion, M. Romain, has been much lamented. They ascended at Boulogne on the 15th of June, with an intention of crossing the channel to England. Their machine consisted of a spherical balloon, 37 feet in diameter, filled with inflammable air, and under this balloon was suspended a small Montgolfier, or fire balloon, ten feet in diameter. This Montgolfier was designed for rarefying the atmospheric air, and thus diminishing the specific gravity of the whole apparatus. For the first twenty minutes they seemed to pursue their proper course; but the balloon seemed much inflated, and the aeronauts appeared anxious to desend. Soon, however, when they were at the height of about three quarters of a mile, the whole apparatus was in flames, and the unfortunate adventurers fell to the ground, and were killed on the spot

On the 19th of July, Mr. Crosbie ascended at Dublin, with a view of crossing the channel to England. To a wicker basket of a circular form, which he had substituted for the boat, he had affixed a number of bladders for the purpose of rendering his gallery buoyant, in case of a disaster at sea. The height to which he ascended at one time was such, that by the intense cold his ink was frozen, and the mercury sunk into the ball of the thermometer. He himself was sick, and he felt a strong impression on the tympanum of his ears. At his utmost elevation he thought himself stationary; but on discharging some gas, he descended to a very rough current of air blowing to the north. He then entered a dense cloud, and experienced strong blasts of winds, with thunder and lightning, which brought him with rapidity towards the surface of the water. The water soon entered his car; the force of the wind plunged him into the ocean, and it was with difficulty that he put on his cork jacket. The bladders which he had prepared were now found of great use. The water, added to his own weight, served as ballast; and the balloon, maintaining its poise, answered the purpose of a sail, by means of which, and a snatch-block to his car, he moved before the wind as regularly as a sailing-boat. He was at length overtaken by some vessels that were crowding sail after him, and conveyed to Dunleary with the balloon On the 22d of July, Major Money, who ascended at Norwich, was driven out to sea, and after being blown about for about two hours, he dropped into the water. After much exertion for preserving his life, and when he was almost despairing of relief, he was taken up by a revenue cutter, in a state of extreme weakness; having been struggling to keep himself above water for about seven hours.

The longest voyage, that had been hitherto made, was performed by Mr. Blanchard, towards the end of August. He ascended at Lisle, accompanied by the Chevalier de L'Epinard, and traversed a distance of 300 miles before he descended. On this, as well as on other occasions, Mr. Blanchard made trial of a parachute, in the form of a large umbrella, which he contrived for breaking his fall, in case of any accident. With this machine he let down a dog, which came to the ground gently, and unhurt. On the 8th of September, Mr. Baldwin ascended from the city of Chester, and performed an aerial voyage of 25 miles in two hours and a quarter. His greatest elevation was about a mile and a half, and he supposes that the velocity of his motion was sometimes at the rate of 20 miles an hour. He has published a circumstantial account of his voyage, described the appearances of the clouds as he passed through them, and annexed a variety of observations relating to aerostation.

It would be tedious to recount the aerial expeditions that were peformed in various parts of our own country, as well as on the continent, in the whole course of the year 1785: more especially as they have afforded us no experiment or discovery of any peculiar importance. The most persevering aerial navigator has been Mr. Blanchard. In August, 1788, he ascended at Brunswick for the thirty-second time. Within two years from the first discovery of this art of navigating the atmosphere, more than forty different persons performed the experiment without any material injury; and it may be justly questioned, says Mr. Cavallo, whether the first forty persons who trusted themselves to the sea in boats escaped so safely. The catastrophe that befel Rozier, and the unpleasant circumstances that

have happened to some of the aeronauts in our own country, have been owing, not so much to the principle of the art, as to want of judgment, or imprudent management in the conduct of it.

Omitting the various uninteresting, though not very numerous, aerial voyages undertaken in various parts of the world, during the 17 years subsequent to the above-mentioned dreadful accident of Pilatre de Rozier and Mr. Romain, we shall only add the account of two aerostatic experiments lately performed in England by Mr. Garnerin, a French aeronaut. The first of these is remarkable for the very great velocity of its motion; the second for the exhibition of a mode of leaving the balloon, and of descending with safety to the ground. On the 30th of June, 1802, the wind being strong, though not impetuous, Mr. Garnerin and another gentleman ascended with an inflammable air, or hydrogen gas, balloon, from Ranelagh gardens, on the south-west of London, between four and five o'clock in the afternoon; and in exactly three quarters of an hour they descended near the sea, at the distance of four miles from Colchester. The distance of that place from Ranelagh is 60 miles; therefore they travelled at the astonishing rate of 80 miles per hour. It seems that the balloon had power enough to keep them up four or five hours longer, in which time they might have gone safely to the continent; but prudence induced them to descend when they discovered the sea not far off. The singular experiment of ascending into the atmosphere with a balloon, and of descending with a machine called a parachute, was performed by Mr. Garnerin on the 21st of September, 1802. He ascended from St. George's parade, North Audley street, and descended safe into a field near the small-pox hospital, at Pancras. The balloon was of the usual sort, viz. of oiled silk, with a net, from which ropes proceeded, which terminated in, or were joined to a single rope at a few feet below the balloon. To this rope the parachute was fastened in the following manner. The reader may easily form to himself an idea of this parachute, by imagining a large umbrella of canvas, about 30 feet in diameter, but destitute of the ribs and handle. Several ropes of about 30 feet in length, which proceeded from the edge of the parachute, terminated in a common joining, from which shorter ropes proceeded, to the extremities of which a circular basket was fastened, and in this basket Mr. Garnerin placed himself. The single rope passed through a hole in the centre of the parachute, also through certain tin tubes, which were placed one after the other, in the place of the handle or stick of an umbrella, and was lastly fastened to the basket; so that, when the balloon was in the air, by cutting the end of the rope next to the basket, the parachute with the basket would be separated from the balloon, and in falling downwards would be naturally opened by the resistance of the air. The use of the tin tubes was, to let the rope slip off with greater certainty, and to prevent its being entangled with any of the other ropes, as also to keep the parachute at a distance from the basket. The balloon began to be filled about two o'clock. There were 36 casks filled with iron filings, and diluted sulphuric acid, for the production of the hydrogen gas. These communicated with three other casks, or general receivers, to each of which was fixed a tube, that emptied itself into the main tube attached to the balloon. At six, the balloon being quite full of gas, and the parachute, &c. being attached to it, Mr. Garnerin placed himself in the basket, and ascended majestically, amidst the acclamations of innumerable spectators. The weather was the clearest and pleasantest imaginable; the wind was gentle, and about west by south; in consequence of which Mr. Garnerin went in the direction of nearly east by north. In about eight minutes the balloon and parachute had ascended to an immense height, and Mr. Garnerin, in the basket, could scarcely be perceived. While every spectator was contemplating the grand sight before them, Mr. Garnerin cut the rope, and in an instant he was separated from the balloon, trusting his safety to the parachute. At first, viz. before the parachute opened, he fell with great velocity; but as soon as the parachute was expanded, which took place a few moments after, the descent became very gentle and gradual. A remarkable circumstance was observed; namely, that the parachute, with the appendage of cords and basket, soon began to vibrate like the pendulum of a clock, and the vibrations were so great, that more than once the parachute, and the basket with Mr. Garnerin, seemed to be on the same level, or quite horizontal: however, the extent of the vibrations diminished as he descended. On coming to the earth, Mr. Garnerin experienced some pretty strong shocks; but he soon recovered his spirits, and remained without any material hurt.

As soon as the parachute was separated from the balloon, the latter ascended with great rapidity, and, being of an oval form, turned itself with a longer axis into an horizontal position.

We now come to the practice of the art. The shape of the balloon is one of the first objects of consideration. As a sphere admits the greatest capacity under the least surface, the spherical figure, or that which approaches nearest to it, has been generally preferred. However, since bodies of this form oppose a greater surface to the air, and consequently a greater obstruction to the action of the oar or wings than those of some other form, and therefore cannot be so well guided in a calm, or in a course different from the direction of the wind, it has been proposed to construct balloons of a conical or oblong figure, and to make them proceed with their narrow end forward. Next to the shape, it is necessary to consider the stuff that is most proper for forming the envelope of the inflammable or rarefied air. Silk stuff, especially that which is called lutestring, properly varnished, has been most commonly used for hydrogen gas balloons; and common linen, lined within and without with paper, varnished, for those of rarefied air. Varnished paper, or gold-beaters' skin, will answer the purpose for making small hydrogen gas balloons; and the small rarefied air balloons may be made of paper, without any varnish or other preparation. The stuff for large balloons of both kinds requires some previous preparation. The best mode of preparing the cloth for a machine, upon Montgolfier's principle, is, first to soak it in a solution of sal-ammoniac and size, using one pound of each to every gallon of water; and when the cloth is quite dry, to paint it over with some earthy colour, and strong size or glue. It may be also varnished over, when perfectly dry, with some stiff, oily varnish, or simple drying linseed oil, which would dry before it penetrates quite through the cloth. The pieces of which an hydrogen gas balloon is to be formed must be cut of a proper size, according to the proposed dimensions of it, when the varnish is sufficiently dry. The pieces that compose the surface of the balloon are like those gores that form the superficies of a globe; and the best method of cutting them is, to describe a pattern of wood or stiff card-paper, and to cut the silk or stuff upon it. To the upper part of the balloon there must be adapted a valve, opening inward, to which is annexed a string passing through a hole made in a small round piece of wood, which is fastened to the lowest part of the balloon, opposite to the valve, to the boat below it; so that the aeronaut may open it as occasion requires, and let the hydrogen gas out of the balloon. To the lower part of the balloon are fixed two pipes of the same stuff with the covering, six inches in diameter for a balloon of 30 feet, and much larger for balloons of greater size, and long enough to reach the boat. These pipes are the apertures through which the hydrogen gas is introduced into the balloon. The boat may be made of wicker work, and covered with leather, well painted or varnished over. The best method of suspending it is by means of ropes, proceeding from the net which goes over the balloon. This net should be formed to the shape of the balloon, and fall down to the middle of it, and have various cords proceeding from it to the circumference of a circle, about two feet below the balloon; and from that circle other ropes should go to the edge of the boat. This circle may be made of wood, or of several pieces of slender cane bound together. The meshes of the net may be small at top, against which part of the balloon the hydrogen gas exerts the greatest force, and increase in size as they recede from the top. A hoop has been sometimes put round the middle of the balloon for fastening the net. This is not absolutely necessary; but when used, it is best made of pieces of cane bound together, and covered with leather. When the balloon and its appendages are constructed, the next object of importance is to procure proper materials for filling it. Hydrogen gas for balloons may be obtained in several ways; but the best methods are by applying acids to certain metals; by exposing animal, vegetable, and some mineral substances, in a close vessel, to a strong fire; or by transmitting the vapour of certain fluids through red hot tubes. In the first of these methods, iron, zinc, and sulphuric acid, are the materials most commonly used. The acid must be diluted with five or six parts of water. Iron may be expected to yield in the common way about 1700 times its own bulk of gas, or 4½ ounces of iron; the like weight of sulphuric acid, and 22½ ounces of water, will produce one cubic foot of hydrogen gas; 6 ounces of zinc, an equal weight of acid, and 30 ounces of water, are necessary for producing the same quantity. It is more proper to use the turnings or chippings of great pieces of iron, as of cannon, &c. than the filings

of that metal, because the heat attending the effervescence will be diminished, and the diluted acid will pass more readily through the interstices of the turnings, when they are heaped together, than through the filings, which stick closer to one another. The weight of the hydrogen gas thus obtained by means of sulphuric acid is, in the common way of procuring it, generally one-seventh part of the weight of common air; and with the necessary precautions for philosophical experiments, less than one-tenth of the weight of common air. We shall conclude this article with a description of some figures explanatory of the subject. Figure 1 (plate Aerostation) represents a balloon, DF, suspended by means of the poles G and H, and the cord, for the purpose of being filled with gas. It is kept steady and held down whilst filling by ropes, which are readily disengaged. A, A, are two tubs, about three feet in diameter, and two feet deep, inverted in larger tubs, B, B, full of water. At the bottom of each of the inverted tubes there is a hole, in which is inserted a tin tube; to these the silken tubes of the balloon are tied. Each of the tubs, B, is surrounded by several strong casks, so regulated in number and capacity, as to be less than half full when the materials are equally distributed. In the top of these casks there are two holes; to one of which is adapted a tin tube, formed so as to pass over the edge of the tub B, and through the water, and to terminate with its aperture under the inverted tub A. The other hole, which serves for supplying the cask with materials, is stopped with a wooden plug. When the balloon is to be filled, the common air is first to be expelled, then the silken tubes are fastened round the tin ones; the iron filings are to be put into the casks, then the water, and lastly the sulphuric acid. The balloon will speedily be inflated by the gas, and support itself without the aid of the rope GH. As the filling advances, a net is adjusted about it, the cords proceeding from the net are fastened to the hoop MN; the boat IK is suspended from the hoop, and whatever is wanted for the voyage is deposited in the boat. When the balloon is sufficiently full, the silken tubes are separated from the tin tubes, their extremities are tied, and they are placed in the boat. When the aeronauts are seated in the boat, the ropes that held the balloon down are slipped off, and the machine ascends in the air, as in figure 2. In fig. 3, is a representation of a part of Mr. Garnerin's balloon in its ascent, to which is attached a parachute, in its contracted state, and below is the car. Figure 4 shews the manner in which Mr. Garnerin descended in the car by means of the expanded parachute, after he had detached it from the balloon. In figure 5 is represented an apparatus, as described by Mr. Cavallo, for filling balloons of the size of two or three feet in diameter with hydrogen gas, after passing it through water. A is a bottle, with the ingredients; BCD a tube fastened in the neck at B, and passing through C, the cork of the other bottle, in which there is a hole made to receive the tube, and to this the balloon is tied. Thus the hydrogen gas, coming out of the tube D, will pass first through the water of the bottle E, and then into the balloon. Two small casks may be used instead of the bottles A and E.

ÆRVA, in botany, a genus of the Monadelphia Decandria class and order. The flowers are polygamous; the calyx five-leaved and patent: the stamina are five; the pistillum is a globulous ovary, having a filiform style, terminated by a bifid stigma: the fruit is an oblong, single-seeded capsule, encompassed by a calyx: there is but one species, viz. Æ. ægyptiaca, or tomentosa, which grows on the sandy calcareous soil of Arabia.

ÆSCHYNOMENE, a word from the Greek, signifying *to be ashamed*, because it retreats from the touch: bastard sensitive plant, in botany, a genus of the Diadelphia Decandria class and order, and of the natural order of Papilio Naceæ, of which there are 12 species, found native in the East Indies, and cultivated in other hot countries. One of the species may be treated as hemp, and is used for the same purposes.

AESCULUS, in botany, a genus of the Heptandria Monogynia class and order, of the natural order of Trihilatæ. There are three species: the first, or common horse-chestnut, was brought from the northern parts of Asia into Europe about the year 1550, and sent to Vienna about the year 1558. From Vienna it was conveyed to France and Italy; but it came to us from the Levant. It is distinguished by the beautiful parabolic form of its branches, the disposition and structure of its digitate leaves, and by the pyramidal bunches of its white flowers, variegated near the centre with yellow or red. Although this tree is now less in esteem for avenues and walks than it formerly was, on account of the early decay of its leaves, it affords an excellent shade; and the

spikes are flowers which appear in May, with the intermixture of large leaves, exhibit a noble appearance. The most eligible situation for these trees is in lawns and parks, where they may be planted singly, and where their fruit will be serviceable to the deer, who are fond of it. This tree is of quick growth; and in a few years it will afford a good shade in summer, and yield plenty of flowers. Trees, raised from nuts, have in 12 or 14 years become large enough to shade two or three chairs with their branches, which in the season are covered with flowers. But the trees are of short duration, and the wood is of little value. It serves, however, for water-pipes, turners' ware, and fuel: and for these uses it is worth the charge of planting, and should be felled in November or December. The horse-chestnut has been employed in France and Switzerland for the purpose of bleaching yarn; and it is recommended in the Memoirs of the Society of Berne, Vol. II. part 2, as capable of extensive use in whitening not only flax and hemp, but silk and wool. It contains an astringent saponaceous juice, which is obtained by peeling the nuts, and grinding or rasping them. They are then mixed with hot rain or running water, in the proportion of 20 nuts to 10 or 12 quarts of water. Wove caps and stockings were milled in this water, and took the die extremely well; and successful trials were made of it in fulling stuffs and cloths. Linen washed in this water takes a pleasing light sky-blue colour; and the filaments of hemp, steeped in it some days, were easily separated. The author of the memoir, above referred to, imagines, that if the meal of the chestnut could be made into cakes or balls, it would answer the purposes of soap, in washing and fulling. The sediment, after infusion, loses its bitter taste, and becomes good food for fowls when mixed with bran. The Edinburgh College have admitted the horse-chestnut into their Pharmacopœia of 1783, on the recommendation of Dr. Gardiner, who says that three or four grains of the powder, snuffed up the nostrils in the evening, operate next morning as an excellent sternutatory, and thereby proves very beneficial in obstinate inflammations of the eyes. A patent was granted in 1796, to Lord W. Murray, for his discovery of a method of extracting starch from horse-chestnuts.

The second species, or yellow-flowered horse-chestnut, is a native of North Carolina, was cultivated with us in 1764, and flowers in May and June.

The third species, or scarlet horse-chestnut, rises to the height of twenty feet, without much extending its branches; its bark is smooth, and the leaves, which are opposite, on long, red petioles, are of a light green.

The common horse-chestnut is propagated by sowing the nuts, after preserving them in sand during the winter: but the scarlet is propagated by grafting it upon stocks of the common horse-chestnut.

The American species are: Æ. paria; Æ. flava; Æ. macrostachya; and Æ. achinata. Of the last there are two varieties, *A.* the glabra, and *B.* the pallida.

ÆTHUSA, in botany, a genus of the Pentandria Digynia class and order, and belonging to the natural order of Umbellatæ or Umbelliferæ: the calyx is an universal spreading umbel, and the partial is also spreading, but small; having no universal involucre, and the partial one placed on the outside, and consisting only of three very long, linear, pendulous leaflets, and the proper perianthium scarcely observable: the universal corolla is nearly uniform, with all the floscules fertile, and the partial has the petals bent in, heart-shaped, and unequal: the stamina are simple filaments, with roundish anthers; the pistillum is an inferior germ, and the styles are reflex, with obtuse stigmas: it has no pericarpium, and the fruit is roundish, streaked, and bipartile: the seeds are two, roundish, streaked, except on a third part of the surface, which is plain. There are four species, the principal is Æ. cynapium, common fool's parsley, or lesser hemlock, which is a common weed in fields and kitchen-gardens, and in a slight degree poisonous. It is easily distinguished when in flower, in July and August, from true parsley and chervil, by the three narrow pendent leaflets of the involucre, placed on the outer part only of the umbel, and by its being a much humbler plant than either of the others. The leaves also, in an earlier state, are of a different form and a darker hue, and, when bruised, emit in a slight degree a disagreeable venomous smell. The safest way to avoid doubt or danger is to cultivate the curled parsley. Most cattle eat it, but it is said to be noxious to geese.

ÆTIOLOGY, that branch of physic which assigns the causes of diseases; in this sense we say the ætiology of the small pox, dropsy, &c.

ÆTIOLOGY, in rhetoric, is deemed a figure of speech, whereby, in relating an event, we, at the same time, unfold the causes of it.

ÆTNA, a famous volcanic or burning mountain in Sicily, situated on the eastern coast, not far from Catania. The height of this mountain is above 10,000 feet above the surface of the sea, and its circumference at the base is 180 miles. Over its sides are 77 cities, towns, and villages, the number of inhabitants of which is about 115,000. From Catania to the summit is the distance of 30 miles, and the traveller must pass through three distinct climates, which may be denominated the torrid, the temperate, and the frigid. Accordingly, the whole mountain is divided into three distinct regions, called the fertile, the woody, and the barren. The first, or lowest region, extends through an interval of ascent from 12 to 18 miles. The city of Catania and several villages are situated in this first zone, and it abounds in pastures, orchards, and various kinds of fruit trees. Its great fertility is ascribed to the decomposition of lava, and of those vegetables, which have been introduced by the arts of agriculture, and the exertions of human industry. The figs, and fruit in general, in this region, are reckoned the finest in Sicily. The lava in this region flows from a number of small mountains, which are dispersed over the immense declivity of Ætna. The woody region, or temperate zone, extends from 8 to 10 miles in a direct line, towards the top of the mountain; it comprehends a surface of about 40 or 45 square leagues. It forms a zone of the brightest green all round the mountain, which exhibits a pleasing contrast to the white and hoary head of the mountain. It is called the woody region, because it abounds with oaks, beeches, and firs. The soil is similar to that of the lower region. The air here is cool and refreshing, and every breeze is loaded with a thousand perfumes, the whole ground being covered over with the richest aromatic plants. Many parts of this region are the most heavenly spots upon earth; and if Ætna resemble hell within, it may with equal justice be said to resemble paradise without. The upper region, called the frigid zone, is marked out by a circle of snow and ice. The surface of this zone is for the most part flat and even, and the approach to it is indicated by the decline of vegetation, by uncovered rocks of lava and heaps of sand, by near views of an expanse of snow and ice, and of torrents of smoke issuing from the crater of the mountain, and by the difficulty and danger of advancing, amidst streams of melted snow, sheets of ice, and gusts of chilling wind. The curious traveller, however, thinks himself amply recompensed, upon gaining the summit, for the peril which he has encountered. At night the number of stars seem increased, and their light appears brighter than usual. The lustre of the milky way is like a pure flame that shoots across the heavens, and with the naked eye we may observe clusters of stars totally invisible in the lower regions. The scoriæ of which the mountain is composed have the same kind of base, containing shorls and feltspars.

AFFIDAVIT signifies an oath in writing, sworn before some person who is authorised to take the same.

In an affidavit, the time, place of habitation, and addition, of the person who makes it are to be inserted.

Affidavits are chiefly used to certify the serving of processes or other matters concerning the proceedings in a court; and therefore should set forth the matter of fact to be proved, without taking any notice of the merits of the cause. They are read in court upon motions, but are not admitted in evidence at trials.

By statute, the judges of the courts at Westminster may commission persons, in the several counties in England, to take affidavits relating to any thing depending in their several courts.

AFFINITY, among civilians, denotes the relation of each of the parties married to the kindred of the other.

Affinity is distinguished into three kinds. 1. Direct affinity, or that subsisting between the husband and his wife's relations, by blood; or between the wife and her husband's relations, by blood. 2. Secondary affinity, or that which subsists between the husband and his wife's relations, by marriage. 3. Collateral affinity, or that which subsists between the husband and the relations of his wife's relations. The degrees of affinity are always the same with those of consanguinity. Hence, in whatever degree of consanguinity the kindred of one of the parties married are, they are in the same degree of affinity to the other.

By the canon law, direct affinity renders marriage unlawful to the fourth generation, inclusive; but the case is otherwise, with respect to the secondary and collateral kinds. It is likewise to be observed, that the affinity contracted by a criminal commerce is an impediment to marriage so far as the second generation: thus, a man is not allowed to marry the sister of a woman he has lain with. Nay, with regard to contracting marriage, affinity is not dissolved by death; for, though

a woman may be admitted a witness for the brother of her deceased husband, she is not allowed to marry him.

Affinity, in chemistry, the attraction manifest between the parts of bodies in chemical combination is, by many authors, distinguished by this name. See Chemistry.

AFFIRMATION, an indulgence allowed by law to the people called Quakers, who, in cases where an oath is required from others, may make a solemn affirmation that what they say is true. But their affirmation is confined to civil cases, and is not allowed in any criminal cause, nor with regard to places of profit or trust under the government.

AFFRAY, or Affrayment, in law, formerly signified the crime of affrighting other persons, by appearing in unusual armour, brandishing a weapon, &c. But, at present, affray denotes a skirmish or fighting between two or more; and there must be a stroke given, otherwise it is no affray.

AFFRONTEE, in heraldry, an appellation given to animals facing one another on an escutcheon, a kind of bearing, which is otherwise called *confrontée*, and stands opposed to *adossée*.

AFT, in the sea language, the same with abaft. See Abaft.

AFZELIA, in botany, a genus of the Didynamia Angiospermia class and order: the calyx is quinquepartite, the corolla campanulated, and the capsule rotundated with hemispheric receptacles. There is but one species, found in Africa, near the equinoctial.

AGAPANTHUS, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Liliacæ: the calyx is a spathe; the corolla is one petalled; the stamina are six filaments, inserted into the throat, shorter than the corolla; the anthers kidney-shaped and incumbent; the pistillum is a superior germ; the style filiform, of the length of three stamens; the stigma simple or trifid; the pericarpium is an oblong capsule; the seeds numerous, oblong, compressed, and enlarged with a membrane. There is one species, viz. A. umbellatus, or African blue lily. This is the African tube-rose hyacinth, with a blue umbellated flower. The root of this plant is composed of thick fleshy fibres; from the same head arises a cluster of leaves, which are thick and succulent, and of a dark green colour. Between these issues the flower stalk, supporting an umbel of blue flowers in a sheath, and each flower standing on a pedicle, about an inch long. The umbel being large, the flowers numerous, and of a light blue colour, make a fine appearance. They come out at the end of August, or beginning of September, and frequently continue in beauty till spring. It is a native of the Cape of Good Hope, from whence it was brought to Holland, and in 1692 it was cultivated at Hampton court.

This plant is propagated by offsets, taken at the latter end of June, planted in separate pots, with light kitchen-garden earth, and placed in a shady situation. In five weeks the offsets will put off new roots, and the pots should then be removed to a more sunny situation, and have more water. In September they will put out their flower-stalks, and toward the end of the month the flowers will begin to open, and should be removed under shelter in bad weather, but in good weather exposed to the free air. Toward the end of October they should be removed to the green-house, and have the benefit of free air, and be occasionally watered during winter, in mild weather, but in frost they should be kept dry.

AGARIC, in botany, a genus of the order of Fungi, and class of Cryptogamia: the pileus or cap has gills underneath, and the gills differ in substance from the rest of the plant, being composed of two lamina, and the seeds are in the gills. There are nearly 400 species. Dr. Withering distributes them into three general classes, comprehending those which have central stems, those with lateral stems, and those which have no stems; and he again subdivides the two former classes into such as have solid, and such as have hollow stems, with decurrent, fixed, and loose gills, respectively. Under these heads, he arranges the species by the colour of the gills, into those whose gills are white, brown, red, buff, yellow, grey, green, and purple. As this ingenious author has formed a system, that serves to facilitate the investigation and description of the several species of Agarics, we shall here give a brief sketch of the principles upon which it is founded. Agarics are composed of a cap or pileus, with gills underneath, and are either with or without stems. The stems are either central or lateral. They have also a root, which is more or less apparent, and some of them, in their unfolded state, wholly enclosed in a membranaceous or leather-like case, called a wrapper. Some of them have also a curtain, or thin membrane, extending from the stem to the

edge of the pileus, which is rent as the pileus expands, and soon vanishes; but the part attached to the stem often remains, and forms round it a ring, which is more or less permanent, as its substance is more or less tender. Of all the species of Agaric, one only has been selected for cultivation in our gardens, viz. the A. campestris, or common mushroom, or champignon. The gills of this species are loose, pinky red, changing to a liver colour, in contact with the stem, but not united to it; very thick set, irregularly disposed, some forked next the stem, some next the edge of the pileus, some at both ends, and in that case generally excluding the intermediate smaller gills. The pileus is white, changing to brown when old, and becoming scurfy; regularly convex, fleshy, flatter with age, from two to four inches, and sometimes nine inches, in diameter, and liquefying in decay; the flesh white. The stem is solid, white, cylindrical, from two to three inches high, half an inch in diameter; the curtain white and delicate. When this mushroom first makes its appearance, it is smooth and almost globular; and in this state it is called a button. This species is esteemed the best and most savoury of the genus, and is much in request for the table in England. It is eaten fresh, either stewed or boiled, and preserved, either as a pickle or in powder; and it furnishes the sauce called Catchup. The field plants are better for eating than those raised on artificial beds, their flesh being more tender; and those who are accustomed to them can distinguish them by their smell. But the cultivated ones are more sightly, may be more easily collected in the proper state for eating, and are firmer and better for pickling. The wild mushrooms are found in parks and other pastures, where the turf has not been ploughed up for many years, and the best time for gathering them is August and September.

AGATE, a fossil compounded of various substances, as chalcedony, cornelian, jasper, hornstone, quartz, &c. These different fossils do not all occur in every agate, commonly only two or three. There are different kinds of agate, as the fortification, the landscape, the ribbon, the moss, the tube, the clouded, the zoned, the star, the fragment, the punctuated, the petrefaction, the coral, and the jasper agate. No country affords finer agate, or in greater abundance, than Germany: it is found in great quantity at Oberstein, where several thousand persons are employed in quarrying, sorting, cutting, and polishing it. It is also found in France, England, Scotland, and Ireland, and very beautiful in the East Indies, where, however, it is confounded with onyx. It is cut into vases, mortars, snuff-boxes, and sometimes into plates for inlaying in tables. Very handsome specimens are made into seals, and the smaller pieces are used for gun flints. It was highly valued by the ancients, who executed many fine works in it: these, however, are only to be found in the cabinets of the rich. The collections of Brunswick and Dresdenar are remarkable for beautiful specimens of this kind.

AGATHOPHYLLUM, a genus of the Dodecandria Monogynia class and order: calyx very minute, truncate; petals six, inserted into the calyx; drupe somewhat globular; nut half five-celled, one-seeded; kernel five-lobed. One species, viz. A. aromaticum, a tree in Madagascar, with an aromatic rufous bark.

AGAVE, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Coronariæ: it has no calyx; the corolla is one-petalled and funnel-shaped; the stamina are filiform; the anthers linear; the pistillum is an oblong germen; the style filiform; the stigma headed and three cornered; the pericarpium is oblong, and the seeds are numerous. There are seven species, of which we shall notice the A. Americana, or great American aloe, whose stems, when vigorous, rise upwards of twenty feet high, (one in the king of Prussia's garden rose to forty feet,) and branch out on every side, so as to form a kind of pyramid, composed of greenish yellow flowers, which stand erect, and come out in thick clusters at every joint. The seeds do not come to maturity in England. When this plant flowers, it makes a beautiful appearance; and if it be protected from the cold in autumn, a succession of new flowers will be produced for nearly three months in favourable seasons. It has been a common error, that this plant does not flower till it is one hundred years old: the truth is, that the flowering depends on its growth; so that in hot countries it will flower in a few years; but in colder climates the growth is slower, and it will be much longer before it shoots up a stem. The first that flowered in England is said to have been Mr. Cowell's at Hoxton, in 1729; but they have occurred so often since that time, that they are now scarcely considered as rarities. Few of the variety with yellow-

edged leaves have yet blossomed. There are hedges of the common agave in Spain, Portugal, Sicily, and Calabria; it flourishes also about Naples, and in other parts of Italy. The juice of the leaves, strained, and reduced to a thick consistence, by being exposed to the sun, may be made up into balls by means of lye-ashes. It will lather with salt water as well as fresh. The leaves, instead of passing between the rollers of a mill, may be pounded in a wooden mortar, and the juice brought to a consistence by the sun, or by boiling. A gallon of juice will yield about a pound of soft extract. The leaves are also used for scouring pewter, or other kitchen utensils, and floors. In Algarvia, where pasture is scarce, they are cut in thin transverse slices, and given to cattle. The inward substance of the decayed stalk will serve for tinder. The fibres of the leaves, separated by bruising and steeping in water, and afterwards beating them, will make a thread for common uses. Varieties of the common American agave, with gold and silver striped leaves, are not now uncommon in the English gardens. The Karatto agave is a variety brought from St. Christopher's, and the name is given to other species of this genus, and has leaves from 2½ to 3 feet long, and about 3 inches broad, ending in a black spine, and more erect than those of the others. This sort has not flowered in England. Linnæus has separated this genus from the aloe, because the stamina and style are extended much longer than the corolla, and the corolla rests upon the germ. Besides, all the agaves have their central leaves closely folding over each other. and embracing the flower-stem in the centre; so that these never flower till all the leaves are expanded, and when the flower is past, the plants die. Whereas the flower-stem of the aloe is produced on one side of the centre, annually, from the same plant, and the leaves are more expanded than in this genus.

AGE, in horsemanship, makes a considerable point of knowledge, the horse being an animal that remarkably shews the progress of his years by correspondent alterations in his body. We have the chief characteristics from his teeth. The first year he has only small grinders and gatherers, of a brightish colour, which are called foal's teeth. The second year he changes his four foremost teeth, viz. two above and two below, and they appear browner and bigger than the rest. The third year he changes the teeth next these, leaving no apparent foal's teeth before, but two above, and two below, on each side, which are all bright and small. The fourth year he changes the teeth next these, and leaves no more foal's teeth before, but one above and below, on each side. The fifth year his foremost teeth are all changed, and the tushes on each side are complete; and those which succeed the last foal's teeth are hollow, with a small black speck in the middle, which is called the mark in the horse's mouth, and continues till he is eight years old. The sixth year there appear new tushes, near which is visible some young flesh, at the bottom of the tush, the tushes being white, small, short, and sharp. The seventh year his teeth are at their full growth, and the mark in his mouth appears very plain. At eight all his teeth are full, plain, and smooth, and the black mark but just discernible, the tushes looking more yellow than ordinary. The ninth, his foremost teeth shew longer, broader, yellower, and fouler, than before, the mark quite disappearing, and the tushes bluntish. At ten no holes are felt on the inside of the upper tushes, which, till then, are easily felt. At eleven his teeth are very long, yellow, black, and foul, and stand directly opposite each other. At twelve the teeth of his upper jaw hang over those of his under. At thirteen his tushes are worn almost close to his chaps, if he has been much ridden; otherwise they will be long, black, and foul.

Age likewise denotes certain periods of the duration of the world. Thus, among christian chronologers, we meet with the age of the law of nature, which comprehends the whole time between Adam and Moses; the age of the Jewish law, which takes in all the time from Moses to Christ; and lastly, the age of grace, or the number of years elapsed since the birth of Christ.

Among ancient historians, the duration of the world is also subdivided into certain periods, called ages; of which they reckon three: the first, reaching from the creation to the deluge, which happened in Greece, during the reign of Ogyges, is called the obscure or uncertain age; the history of mankind, during that period, being altogether uncertain. The second, called the fabulous or heroic, terminates at the first olympiad; where the third, or historical, age commences.

The ancient poets also divided the duration of the world into four ages, or periods; the first of which they called the

golden age, the second the silver age, the third the brazen age, the fourth the iron age. Not unlike these are the four ages of the world, as computed by the East Indians, who extend them to a monstrous length.

AGE, in law, signifies certain periods of life, when persons of both sexes are enabled to do certain acts, which, for want of years and discretion, they were incapable of before. Thus, a man at twelve years of age ought to take the oath of allegiance to the king, in a leet: at fourteen, which is his age of discretion, he may consent to marriage, choose his guardian, and claim his lands held in socage.

Twenty-one is called full age, a man or woman being then capable of acting for themselves, of managing their affairs, making contracts, disposing of their estates, and the like; which before that age they could not do. A woman is dowable at nine years of age, may consent to marry at twelve, and at fourteen choose her guardian, and at twenty-one may alienate her lands.

AGE, in military affairs. A young man must be fourteen years of age, before he can become an officer in the line, or be entered as a cadet at Woolwich. Persons may be enlisted as soldiers from sixteen to forty-five; after the latter age, every inhabitant is exempted from serving in the militia.

AGENT, in law, a person appointed to transact the business of another. It is a principle of law, that whenever a man has a power, as owner, to do a thing, he may, as consistent with his right, do it by deputy, either as agent, factor, or servant. If a person be appointed a general agent, the principal is bound by all his acts. But an agent, specially appointed, cannot bind his principal by an act whereby he exceeds his authority.

AGERATUM, *maudlin*, in botany, a genus of the Syngenesia Polygamia Æqualis class of plants, with a monopetalous personated flower, and an oblong membranaceous fruit, divided into two cells, which contain a number of minute seeds, affixed to a placenta. There are two species.

AGGREGATE, in botany, is a term used to express those flowers which are composed of parts or florets, so united or incorporated by means either of the receptacle or calyx, that no one of them can be taken away without destroying the form of the whole. They are opposed to simple flowers that have no such common part, which is either the receptacle or the calyx, and are usually divided into seven kinds, viz. the aggregate, properly so called, whose receptacle is dilated, and whose florets are supported by foot-stalks; such are the blue daisy, thrift, or sea-pink, &c.: the compound, which consist of several florets, that are placed, without partial peduncles, on a common dilated receptacle, and within a common perianthium; and where each floret hath its proper calyx; it is also a perianthium: umbellate, when the flower consists of many florets placed on fastigate peduncles, proceeding from the same stem or receptacle; and which, though of different lengths, rise to such a height as to form a regular head or umbel, flat, convex, or concave: cymous, when several fastigate peduncles proceed from the same centre, like the umbel, and rise to nearly an even height; but, unlike the umbel, the secondary or partial peduncles proceed without any regular order, as in sambucus, viburnum, &c.: amentaceous, which have a long common receptacle; along these are disposed squamæ or scales, which form that sort of calyx called the Amentum: glumose, which proceed from a common husky calyx belonging to grasses, called Gluma, many of which flowers are placed on a common receptacle, called Rachis, collecting the florets into the spikes, as triticum, hordeum, bolium, &c.: and spadiceous, which have a common receptacle, protruded from within a common calyx, called Spatha, along which are disposed several florets. Such a receptacle is called a Spadix, and is either branched, as in phœnix; or simple, as in narcissus, &c. In this last case, the florets may be disposed all around it, as in calla, draconitum, &c.; on the lower part of it, as in arum, &c.; or on one side, as in zostera, &c. These flowers have generally no partial calyx.

AGGREGATE, in the Linnæan system of botany, is one of the natural methods of classing plants, and comprehending those which have aggregate flowers.

AGGREGATION, in chemistry, denotes the adhesion of parts of the same kind. Thus, pieces of sulphur united by fusion form an aggregate.

AGIO, in commerce, a term chiefly used in Holland and at Venice, where it denotes the difference between the value of bank stock and the current coin. Money in bank is commonly worth more than specie: thus, at Amsterdam, they give 103 or 104 florins for every 100 florins in bank. At Venice, the agio is fixed at 20 per cent. See EXCHANGE. Agio is

also used for the profit arising from the discounting a note, bill, &c. Agio of assurance, is the same with what we call policy of assurance. See ASSURANCE.

AGREEMENT, in law, signifies the consent of several persons to any thing done, or to be done.

There are three kinds of agreement. First, an agreement already executed at the beginning, as when money is paid, or other satisfaction made for the thing agreed to. Secondly, an agreement after an act done by another, to which a person agrees: this is also executed. Thirdly, an agreement executory, or to be executed in time to come.

An agreement put in writing does not change its nature; but if it be sealed and delivered, it becomes still stronger; nay, any writing under hand and seal, or a proviso amounting to an agreement, is equivalent to a covenant.

AGRICULTURE, is the science which explains the means of making the earth produce, in plenty and perfection, those vegetables, which are necessary to the subsistence or convenience of man. Its practice demands a considerable knowledge of the relations subsisting between the most important objects of nature. It is eminently conducive to the advantage of those actively engaged in it, by its tendency to promote their health, and to cherish in them a manly and ingenuous character; and every improvement made in the art must be considered as of high utility, as it facilitates the subsistence of a greater proportion of rational and moral agents; or, if we suppose the number to be unincreased, furnishes them with greater opportunities than could be possessed before, of obtaining that intellectual and moral enjoyment, which is the most honourable characteristic of their nature. The strength of nations is in proportion to their skilful cultivation of the soil; and their independence is secured, and their patrotism animated, by obtaining from their native spot all the requisites for easy and vigorous subsistence.

Not only to raise vegetables for the use of man, but those animals also which are used for food, is obviously therefore part of the occupation of the husbandman; and to assist him in his operations, other animals are to be reared and fed by him, to relieve his labours by their strength and endurance of exertion. In cold and comparatively infertile climates, the services of these creatures are particularly important, if not absolutely indispensable, and their health and multiplication become, consequently, objects of great and unremitted attention.

The period of the introduction of agriculture into Britain is unknown. Pliny observes that, at the time of the Roman invasion, the inhabitants were acquainted with certain manures, particularly marl. During the possession of the island by the Romans, great quantities of grain were exported from it, and it cannot be doubted that, as in various other respects, the rude inhabitants derived advantage from their enlightened conquerors; they were eminently benefited by their agricultural experience. Amidst the series of contests and confusions which followed the final abandonment of Britain by the Romans, the art and practice of husbandry must be presumed to have become retrograde. From the Norman conquest, however, it derived fresh vigour, as a considerable number of Flemish farmers, by this revolution, became proprietors of British estates, and introduced that knowledge of the means of cultivation, for which their own country had been long distinguished.

Before the sixteenth century few data are afforded, with respect to the details of agricultural practice in this island. At this period it derived a valuable impulse from the exertions of Fitzherbert, a judge of the common pleas, whose treatises on the subject were read with avidity, and, while they abounded in instruction, excited a taste and emulation for the pursuits of husbandry. Sir Hugh Platt followed this path of genuine patriotism with great assiduity, modesty, and public advantage, treating particularly on the subject of manuring. Gabriel Plattes held out to his countrymen the light of genius, guided by experience. Captain Blyth, in 1652, published a judicious treatise, containing directions for watering lands. And Hartlib, the friend of Millan, in a work called the Legacy, suggested the establishment of a national institution for the encouragement of husbandry, and stimulated to the practice of it a number of country gentlemen, whom the violence and changes of the times had reduced to a situation, in which they found it requisite to avail themselves of all means and resources to extricate themselves from comparative impoverishment. Evelyn and Jethro Tull were, at a somewhat later period, of eminent service, in directing the attention of their contemporaries from the grossness and pollutions of voluptuousness, to this most valuable

department of art; the former, by his treatise on plants; the latter, by his recommendation of the practice of drill husbandry. Since their successful and ingenious efforts, a series of valuable experimentalists and writers have performed to their country very essential service, by communicating the most useful information, and exciting a spirit of acute research and unwearied exertion.

In France, the political expedience of guarding against that scarcity, which, in time of war, either necessitated the yielding to harsh terms from the enemy, or exposed to the miseries and horrors of famine, by continued hostilities, induced the government, in the late reigns, to bestow on the subject of agriculture considerable attention, and to hold out numerous encouragements to it. The court was present at various experiments in husbandry. Prize questions were proposed at Lyons, Bourdeaux, and Amiens, for its promotion, and no less than fifteen societies, for the express purpose of advancing agriculture, were established, with the approbation, probably at the suggestion, of the governing powers. But, notwithstanding all those efforts, which, however, can by no means be presumed to have been totally useless, French husbandry continued in a very deplorable state, ascribable, in a great degree, to that tenure of lands, by which, through the greater part of the kingdom, the landlord contributed the stock, and the occupier the labour, dividing the profits in certain proportional shares. This circumstance, with several others, operated to keep the cultivation of this country in an extremely low state, and a comparative estimate of the produce of an English and of a French estate, of precisely similar natural advantages, at the period when this practice prevailed, would shew that, in consequence, principally, of so absurd and perverse a regulation, the superiority of the former to the latter was at least in the ratio of 36 to 25. But the revolution of France, changing every thing, has swept away, with many excellent individuals, and some valuable institutions, a practice so impolitic and injurious; and although our intercourse with that country, since this event, has scarcely been such as to afford accurate and detailed information of the present state of its husbandry, it cannot easily be doubted, that the repeated transfers of landed property, the annihilation of partial burdens upon cultivation, the researches of ingenious chemists, and the general view of government to the productiveness of its territory, and to the promotion of its arts and sciences, must be connected with considerable improvement in this most valuable of national concerns.

In Germany, lectures have for many years been given on this subject, in various states of it; and several princes in the empire, particularly the present king of Bavaria, have directed to it their particular attention and patronage. In Russia, the late Empress gave it every facility which could be applied in the semi-barbarous state of her dominions, and sent gentlemen into this and other countries, with a view to acquire information on rural economy, for the benefit of their own. In the Dutchy of Tuscany, the Archduke Leopold recently diffused the active spirit of improvement by which he was himself animated, and an academy was endowed for the promotion of agriculture. A society for the same purpose was instituted about the year 1759, at Berne, in Switzerland, consisting of men of great political influence, and also of great personal experience in rural economics. The Stockholm Memoirs sufficiently evince that Sweden, under the influence of the great Linnæus, applied to this science with extraordinary success and advantage. Even the indolence and pride of Spain were roused to exertion on this interesting subject, and the government of that country made overtures to the Swedish philosopher, for the superintendance of a college directed to the advance of natural history, and the art of husbandry.

In our own country, however, from a happy combination of circumstances, the exertions of individuals, societies, and government, have been directed, within the last thirty years, to the subject under consideration, with more energy and effect than have been displayed in any other part of Europe. The gentry and nobility have liberally patronized, and many of them judiciously and successfully practised it. The Royal Society, the Society of Arts, and various others, have been of distinguished service in collecting and diffusing information, and in promoting a spirit of emulation, with respect to the management and productions of their native soil. The names of Kaims and Hunter, of Anderson and Marshall, of Sinclair and Young, are celebrated by publications, exhibiting a union of philosophical sagacity and patient experiment; the results of which have been of incal-

culable advantage; and to the efforts of these and other individuals it may be ascribed, that a board of agriculture was established by the government in 1793, whose exertions in procuring and publishing intelligence on the objects of its establishment have entitled it to the highest credit. By its agricultural surveys, by its diffusion of rewards for important discoveries, and of premiums for valuable treatises, and by its exertions at critical periods of scarcity, its utility and merit may be considered not only as decided, but distinguished. It has the power of directing public attention to any topics particularly requiring practical research or illustration, and possesses the means of most advantageously diffusing its collections, circumstances of high importance to the utility of the establishment. It must be regarded as its privilege, as well as duty, to suggest, from time to time, to the legislature, means for removing various impediments, still existing, to the perfection of the art, for the promotion of which it is expressly instituted.

On Inclosing and Draining.

Inclosing of lands must be considered as the grand foundation of all improvements. When remaining open, litigations between neighbours are perpetually occurring, and the ingenuity of any individual proprietor is of little use to him, as he is obliged to follow the practice pursued by the ignorant and obstinate occupiers of the common property in which he shares. In connection with inclosures may be considered the practice of draining lands, which is the next step in rendering them productive. The superabundance of water is no less injurious to vegetation than the absolute want of it; and, whether arising from rain stagnating on the surface, or from springs in the interior of the earth, it is one of the most important objects of the farmer to prevent its pernicious consequences. For this purpose, open or visible drains are in many cases adopted; while in others, hollow ones, so called from their being concealed in covered trenches, are preferred. The width and depth of open drains must be regulated by the variety of soil and situation to which they are applied. To prevent, however, the sides from falling in, they must at top be three times the width they have at bottom; while their direction must obviously, and of necessity, be descending, it should, at the same time, not be steep, as this would form inequalities, and bear down their sides by the rapid rush of the water. All open drains should be cleared, at least, once in every year; which regular repairs may, in some cases, render them in the end more expensive than those denominated hollow, which will sometimes last for several generations unimpaired, but demand originally a far greater sum for their completion.

The practice of hollow draining was known by the Roman writers on agriculture, and is particularly mentioned by them. In stiff clays it is of little service, and it is practised with desired effect only where the soil is of that porous substance, which easily admits the passage of the water through it Opinions differ with regard to the season for carrying these works into execution; some, with plausible reason, preferring the summer, and others, having nearly as much to state in recommendation of winter for the purpose. The depth of the drain, from the surface of the land, should generally be from twenty-six inches to thirty-two; and the principal rule for their depth is, that they should be secured from receiving injury from the feet of horses or cattle ploughing on the spot under which they are made. It is desirable to constitute the drain in such a manner that the stones may lean towards each other, so as to form a triangle, of which the bottom of the drain forms the base: in which case, the width of a foot may be regarded as sufficient for them. The ditches constructed for these drains must be executed with great neatness and care; and with respect to filling them up, which they should be about ten inches deep, if stones are plentifully at hand, they should be applied for this purpose But in many places, faggot-wood, horns, bones, straw, fern, and even turf, laid in like a wedge, are all used in different situations; and drains constructed of these materials, thirty years ago, are found in several places effectually to answer their purpose still. By many persons, straw, twisted into a very large rope, has been successfully laid in the bottom of the ditch; and by others, after twenty years experience, the white thorn has been recommended as answering better than all other materials.

Injurious moisture in land arises often from springs in the bowels of the earth. The person who first published the method of draining land, in these circumstances, was Dr. John Anderson, of Aberdeen, while Mr. Elkington was actually

practising upon the same principle, in various parts of England, with complete success; and at length obtained from the British parliament a thousand pounds, as the discoverer of so valuable an improvement. In Italy and Germany, however, it is stated, upon respectable authority, that the art has been long known and practised. Some of the strata of which the earth is composed will admit the free passage of water through them, while others effectually resist it. Gravel is obviously characterised by the former quality, and clay by the latter. The upper part of mountains is frequently composed of gravel, which extends far into their depth, and conveys with it the water received upon their surface from the clouds. Meeting with layers of clay or rock, however, the water is unable to permeate them, and flows upon the upper part of them obliquely, according to that general direction of the layers or laminæ, which form the earth towards the plain or valley. After descending for some way, the layer of gravel along which the water had passed, and from which it could not penetrate the clay, flowing only on its surface, often passes, in consequence of the obliquity just mentioned, under new strata of materials, consisting of clay, or some substance equally difficult to be penetrated by moisture. The water is thus confined between impervious beds. If the layer of gravel suddenly stops, in such circumstances, as it often does, the water which it had conveyed between these two beds, deriving fresh accumulation perpetually from its original source, will at length permeate the superior layer, ascending through its weaker parts, and arriving at last at the surface, will there stagnate. The art of draining lands in this situation (the principle of which, in whatever research or casualty its discovery originated, is of such happy application) consists merely of digging or boring with an auger into the earth, so as to reach the layer of gravel; the water in which, finding an easy and rapid access upwards by this vent, no longer presses in its former diffused manner, to the injury of the superior clay, which will consequently cease to nourish moss and weeds through redundant moisture, and be fitted for the purposes of useful cultivation. The application of this principle to the purposes of improved husbandry may be considered at present as in its infancy. It may be presumed that, in future periods, it may be carried to an extent of incalculable utility, and be connected with the supply of navigable canals, and the movement of machinery adapted to various objects of art and commerce. The manner in which the various strata are intermingled with each other must, it is obvious, as nearly as possible, be ascertained, before this practice can be applied with certainty of success; and the surest way of discovering their direction consists in examining the beds of the nearest rivers, and the appearance of their steep and broken banks. The examination of pits, wells, and quarries, in the vicinity, will also contribute information on the subject. Rushes and other plants, which grow only in moisture injurious to other vegetables, will likewise often indicate where a collection of water is impeded in its course below, and consequently presses upward, to the destruction of useful vegetation. In draining a large bog, it will be generally proper to dig a trench from one end of it to the other, with cross trenches at considerable distances, to allow the water a free discharge, by frequently piercing the bottom, at which the springs are to be found, with an auger. A single perforation will frequently, indeed, complete the object. Instances have occurred, in which water thus raised has been made to ascend, by erecting round the perforation a building of brick, lined both sides with clay, above the level of the bog, applicable to a variety of purposes, and conveyed by pipes, or otherwise, to a considerable distance. Detailed regulations for the application of this important principle, so productive a source of improved cultivation, are precluded by the assigned limits of this article.

On Fences.

Without firm and close fences, the husbandman might as well cultivate open fields as inclosures, which in these circumstances, indeed, are only nominally such. He is under perpetual and well-founded apprehensions, lest cattle of his own or his neighbours should break into his corn or hay-fields. To prevent these painful apprehensions and irreparable mischiefs, every attention must be bestowed on the fences of a farm. Large and rich pastures may most easily be divided into fields of ten acres each, by which the land is less liable to be injured through the restlessness, and wild and perpetual movements of cattle, which occur in extensive grounds, where they are collected in considerable numbers. Dividing banks being raised, they may be

connected with the system of draining by a ditch on each side, about three feet wide at top and four deep. The bank or border should be about the width of six feet at the bottom, lessening gradually to three at the top, at which the height from the ground should be five or six feet. On each side of the bank should be planted a single row of quick thorn. If the thorn be of the bullace or damson kind, it will be productive and profitable. On the top of the border filbert nuts may be planted at the distance of three feet; and, in the middle, apple trees at the distance of five feet. This fence would occupy about 13 feet, and in the neighbourhood of London, particularly, would be found not only effectual for its main purpose, but a source of income, as well as the means of defence. The hawthorn, the black thorn, and the holly, the willow, the black alder, and the birch, have all been recommended by observant and experienced men, as admirably calculated to secure fields from the irruptions of cattle, and will be employed for the purpose, according as particular circumstances of dryness or moisture, or other considerations recommend their application. Where there is an abundance of flat-stones, fences are frequently composed of them; and, though not so agreeable to the eye as the others, and requiring frequent repair from the stones being displaced by cattle, when kept in order they are the most effectual defence that can be procured. With respect to hedges, (which in this country are more usual as well as more pleasing than walls, and which, perhaps, cannot in general be formed of any thing preferable to the thorn, considering the quickness of its growth in congenial soil, in which it shoots six or seven feet in a single season, and that it is more disposed to lateral shoots than all other trees, and by its prickles is especially calculated for the object in view, in the construction of hedges,) the proper method of repairing them is unquestionably by plashing. This has been defined a wattling made of living wood. The old wood must, in the first instance, be all cleared from the hedge, together with brambles and irregularly growing stuff, and along the top of the bank should be left standing the straightest and best grown stems of thorn, hazel, elm, oak, or ash, about the number of six in a yard. The next step is to repair the ditch, which, in the driest soils, should never be less than three feet wide at top, by two and a half deep, and six inches wide at bottom; and in all very moist ones should be at least four feet by three, and one at bottom. The earth removed from the ditch should be thrown upon the bank, after which the repair of the hedge commences, and those of the stems above mentioned, left in cutting the old hedge, which grow in the direction in which the new hedge is to run, are cut off, to serve as hedge stakes for it, which being chosen as much as possible of sallow and willow readily grow, and effectually preserve the new part from falling or leaning. The remainder of the wood left standing is then plashed down. One stroke is given to the stick near the ground, and another about ten or twelve inches higher, just deep enough to slit out a part of the wood between the two, leaving the stem supported by about a quarter of its original size; it is then laid along the top of the bank, and weaved among the hedge-stakes. Dead thorns are sometimes woven among them, where there happens to be a scarcity of living wood. After this operation the hedge is eddered in the usual manner. The greatest part of the hedge thus consists of living materials, and the importance of this circumstance cannot be too strongly insisted upon, as a compact and lasting fence is thus formed, while those hedges which are constructed of dead materials speedily decay, and crumble into the ditch. It would be endless to detail all the varieties of fence which peculiar circumstances may have rendered expedient, or human ingenuity may have invented. The most usual and most generally applicable are those which have been mentioned.

Irrigation.

Watering of meadows was used in England even in the days of Queen Elizabeth, and was carried on upon a large scale by Rowland Vaughan, in the golden valley of Herefordshire. He likewise published a treatise on the subject. After this period, and about a century since, it was introduced by Mr. Welladvise into Gloucestershire, with abundant proofs of its efficacy and importance. So slow, however, is the progress of improvement, that it is only of late years that this overflowing of grounds in nearly all other situations as well as in level ones, has been brought considerably into use. It is a practice by which, in mild seasons, grass is produced in extreme abundance, even so early as in March; grass, too, particularly nutritious as well as plentiful, on which cattle which have win-

tered hardly thrive with great rapidity, and on which young lambs feed with surprising advantage. Between March and May, the feed of meadows, in consequence of this practice, is estimated at worth one guinea per acre; after which an acre will yield two tons of hay in June, while the after-math may be valued at twenty shillings. In consequence of this management, moreover, the land is continually improving in quality, its herbage advancing in fineness, the soil becoming more firm and sound, and the depth of its mould being augmented. It may be estimated that in each county in England and Wales two thousand acres may be increased in value one pound per acre, by means of irrigation; a national advantage of serious moment, and drawing after it the great improvement of other lands, and the employment of many honest and industrious poor. The principles on which the practice depends have no portion of difficulty and complexity whatever. Water will always rise to the level of the receptacle from which it is derived. All streams descending in a greater or less degree, which is indicated by their smooth and slow or their agitated and noisy progress, it is obvious that a main or trench may be taken from a river which will convey water over the land by the side of that river to a considerable distance below the head of the main, where the river from which it is taken flows greatly below it. As water, however, if left to stagnate upon land, does it very considerable injury, instead of benefiting it, by cherishing flags, rushes, and other weeds, it is requisite to ascertain, before it be introduced upon any spot, that it can be easily and effectually drained off.

The muddiness of the water applied is stated by some to be of little consequence, and several writers have even laid it down as a maxim, that the purer or clearer the water is, the more beneficial are its effects. These opinions, however, appear to be directly contradicted by experience; and it may be affirmed, that the mud of water, particularly in some situations, is nearly of as much consequence in winter watering, as dung is in the improvement of a poor upland field. Every meadow will be found productive, proportionally to the quantity of mud collected from the water. Those meadows which lie next below any village or town, are uniformly most rapid and plentiful in their growth. So well known is this truth, that disputes are perpetually arising concerning the first application of water to lands; and when mud is supposed to be collected at the bottom of a river, or in ditches, many persons will employ labourers with rakes, for several days together, to disturb it, that it may be carried down by the water, and spread upon the meadows. The more turbid and feculent the water, the more beneficially it acts. Hasty and violent rains, producing floods, dissolve the salts of the circumjacent lands, and wash from them considerable portions of the manure, which naturally or factitiously had been deposited on them. Water from a spring depends in no small degree for the quantity of nutriment it affords to vegetables, on the nature of the strata over which it passes. If these be metallic, or consisting of earth partaking of the sulphuric acid, it may be really injurious. But that which passes over fossil chalks, or any thing of a calcareous nature, will highly promote the process of vegetation. That which has run a long way is, almost always, preferable to what flows over land immediately from the spring.

In mid-winter great attention should be applied to keeping watered land sheltered by the water from the rigour of night frosts; but during the whole winter it should be withdrawn once in every twelve days, to prevent its rotting and destroying the roots of the grass. Every meadow should also be attentively inspected, to preserve the equal distribution of the water over it, and to remove obstacles arising from the influx of weeds and sticks, and other similar causes. In the month of February particular caution is requisite. If the water be suffered to remain many days together upon the land, a white scum, extremely pernicious, is the consequence; and if the land be exposed, without drying during the course of the day, to one severe night frost, the herbage will often be completely cut off. Both these causes of injury must be carefully avoided. About the middle of February half the quantity of water previously used will be better than more, all that is requisite now being to keep the ground moist and warm, and to hasten the progress of vegetation; and in proportion as the weather becomes warmer the quantity introduced should proportionally be diminished. An important maxim in the application of water is, to bring it on as plentifully as possible, but to let it pass off by a brisk and nimble course, as not only its stagnation is injurious, but by indolently creeping over the land, it is of much less advantage than when passing off quickly. The spring feeding ought never to be done by heavier

cattle than sheep or calves, as others would do extreme injury, by poaching the ground with their feet, and spoiling the trenches. The barer the meadows are fed towards the close of April, the better. After clearing, they should have a week's watering, with a careful attention to every sluice or drain.

With respect to the application of floods, a general rule, of no slight importance, is, that the farmer should avail himself of them whenever the grass cannot be used, as the sand and mud brought down by them increase and enrich the soil; but that he should avoid them when the grass is long, or soon to be cut, as in flat countries it is frequently spoiled by them, and much of the matter which they bring down, sticking to the grass, renders it peculiarly unpleasant to cattle, which have been known in some instances rather to starve than use it.

So great is the importance of irrigation, that governments would be fully justified in giving facility to undertakings for conducting it on an extensive plan. The fertility, or, in other words, the national wealth, capable of being derived from the application of cold water, which is at present allowed to flow uselessly away, to the purposes of agriculture, is well worthy the attention of the enlightened and benevolent statesman. In the neighbourhood of the cities of Milan and Lodi, Mr. Young observes, that the exertions in irrigation are truly great and even astonishing. " Canals are not only numerous and uninterrupted, but conducted with great skill and expense. Along the public roads, almost every where, there is one canal on the side of the road, and sometimes there are two. Crossones are thrown over these on arches, and pass in trunks of brick or stone under the road. A very considerable one, after passing for several miles by the side of the highway, sinks under it, and also under two other canals, carried in stone troughs a foot wide. The variety of directions in which the water is carried, the ease with which it is made to flow in opposite directions, and the obstacles which are overcome, are objects of admiration. The expense thus employed in the twenty miles from Milan to Lodi is immense; and meritorious as many undertakings in England are, they sink to nothing in comparison with these truly great and noble works. So well understood is the value of water in this country, that it is brought by the farmer (who has the power of conducting it through his neighbour's ground, for a stipulated sum, and under certain regulations, to any distance that may suit him) from a canal of a certain size, at so much an hour per week, and even from an hour down to a quarter, The usual price for an hour per week in perpetuity is fifteen hundred livres."

Manure, &c.

Ingenious theories have too often, in agricultural treatises, usurped the place of recitals of attentive and patient experience. To the latter, the judicious reader will ever bend his attention with pleasure and advantage, rejoicing that, while the systems of men are seen to vanish, one after another, in rapid succession, like the waves of the ocean, the course of nature is constant, and may be depended upon through all generations and ages. Of all the expenses incurred by the husbandman, none so rarely disappoints its object as that which he employs in manures. The use of lime in this connection has been long decidedly established. It reduces to mould all the dead roots of vegetables, with which the soil abounds. Its useful operation depends upon its intimate mixture with the land; and the proper time therefore to apply it is, when both are in that pulverized state in which this union can be best completed. If left to be slaked by humid air, or casual rain, it is seldom perfectly reduced to powder. The proper method is, to place it in heaps on the ground on which it is intended to be spread, to slake it there with a due quantity of water, and afterwards to cover it with sod, to preserve it from the rain. If long slaked, however, before it is spread, it runs into clots, and becomes less operative for its purpose; besides which, it loses in such circumstances its caustic quality, on which account it should be brought home as short a time as possible before its intended application. Lime should not be permitted to lie all winter on the surface of the ground after being spread, for a similar reason, as also because it is washed down into the furrows; and on the sides of hills the whole is apt to be carried off by the winter torrents. It should be spread, and mixed with the soil immediately before sowing. The quantity to be laid on depends upon the nature of the lands, which, if strong, will easily bear a hundred bolls per acre, while thin and gravelly ones will require only thirty or forty, and upon meadow ones fifty or sixty will be found sufficient.

Marl is valuable as a manure in proportion to the quantity of calcareous earth which it contains, which in some instan-

ces amount to one half. When of this quality, it may be regarded as the most substantial of all manures, converting the weakest ground nearly into the most productive. It is the best of manure for clay soils, in which all agricultural writers are perfectly agreed. Before its application, the land should be cleared of weeds, and smoothed, that it may be evenly spread; after which it should remain all winter on the surface. Its usefulness depends on its pulverization and close union with the soil to which it is applied. Frost, and a frequent alternation of dryness and humidity, contribute greatly to reduce it to powder, on which account it should, as much and as long as possible, be exposed to their influence. The proper season for marling land is summer. The best grain for the first crop after marl is oats. But, whatever be the crop, the furrow should be always ebbed, as otherwise the marl, which is a heavy body, sinks to the bottom of it.

Gypsum, or plaster of Paris, is commonly used in Switzerland and North America as a manure, and has been tried in this country with stated results of a very different description. Experiments, however, respecting its efficacy and advantages, do not appear yet to have been made with sufficient accuracy to justify a final opinion respecting it. In Cornwall and other counties, sea sand is laid upon the land in considerable quantities, and found extremely useful in softening stiff clays, and rendering them pervious to the roots of plants. Chalk, or powdered limestone, will also answer this important end; and sand, together with lime perfectly extinguished, will, more effectually than any thing else, open its texture, and prepare it for whatever is intended to be sown on it.

The true nourishment of vegetables consists of water, coal, salts, and different kinds of earths, which are ascertained to be the only substances common to vegetables, and the soils in which they grow. In favourable weather, grasses and corn absorb and perspire nearly half their weight of water every day. The great problem with respect to manuring or fertilizing a soil appears to be, how to render coal soluble in water for the purposes of vegetation, and to discover that composition of the different earths, which is best adapted to detain the due proportion of moisture. With respect to the former, the fermentation of dung appears to be the best method hitherto discovered; and as to the different kinds of earths to be applied for the improvement of particular soils, the experiments of Mr. Kirwan, to whom the world is indebted for much elaborate and ingenious analysis on the subject, have led him to several conclusions, which will be briefly noticed. Clay soils, being defective in constitution and texture, want the calcareous ingredient, and coarse sand. The former is supplied by calcareous marl, and both are furnished by limestone gravel. Marl and dung are still more beneficial, as dung supplies the carbonaceous principle. Sand, chalk, or powdered limestone, will either of them answer this purpose, though less advantageously. Coal ashes, chips of wood, burnt clay, brick-dust, and even pebbles, may be applied with this view. For clayey loam, if deficient in the calcareous ingredient, chalk is an excellent manure; if in the sandy ingredient, sand is the obvious and easy remedy; a deficiency in both will be best supplied by siliceous marl, limestone gravel, or effete lime with sand. The most effectual application for the chalky soils, which want both the argillaceous and the sandy ingredients, is clayey or sandy loams. For chalky loam, the best manure is clay, because this soil is chiefly defective in the argillaceous ingredient. Calcareous marl is the best manure for sandy soils. For sandy loams, chalk should be followed by clay; and for vitriolic soils, lime, or limestone gravel, or calcareous clay, is peculiarly applicable.

Not only sea-sand, but sea-weeds also, may be employed to considerable advantage as manure. For lands on the coast it may be procured, not only in any quantities, but at a trifling expense. The weeds of rivers are also extremely useful for the same purpose. The refuse of slaughter-houses and oil cakes are well adapted to fertilize the soil, but in most situations not easily to be obtained at a reasonable rate.

In almost all circumstances, the industry and ingenuity of the occupier must be depended on for raising on the spot an adequate quantity of dung for its manure; and for this purpose it is expedient that, in such circumstances, as little as possible of the hay and straw raised upon the premises should be sold from them. This tenaciousness on the part of the farmer will prove the constant source of improvement. With a view to turn his means of manure most advantageously to account, he should draw into his farm yard, at the most leisurely season of the year, before the time of confining his cattle to fodder,

as much marl, turf, dry mud, loam, and other applicable articles, as will cover its surface to the depth of twelve inches. If there be many hog-houses, stables, and cow-stalls, that are cleansed into the yard, on such spots these materials should be spread more thickly. Bog peats, if near at hand, should never be neglected. These peats may be regarded as vegetable dunghills, and their easy accessibility in this connection will be regarded as of extreme utility and consequence. Before foddering is begun, the whole yard should be well littered, for which stubble, fern, and leaves, are well adapted. No money laid out by the farmer is more wisely and successfully expended, than that which he employs in procuring, at a reasonable rate, great quantities of litter, by which his cattle are enabled to lie dry and warm, and the mass of manure which he raises is much larger and cheaper than he could procure in any other mode. Fern abounds in alkaline salts, and must therefore obviously produce very valuable dung: it requires, however, to be rotted well, and is more difficult to be so than straw. In woodlands, leaves may be collected at slight expence, and will make admirable litter and dung. In the neighbourhood of marshes, rushes, flags, and coarse grass, may all be easily procured, and will be exceedingly serviceable. After these exertions and preparations, the farmer must strictly confine his cattle during the winter, not by tying them, as some have done, but so as completely to prevent their roaming in the adjoining pastures. By thus confining all the cattle upon straw, and turnips, and hay, as may be requisite, the necessary quantity of animal manure will be obtained to make the compost of the several ingredients ferment, rot, and turn to rich manure, while without these animal materials, the heap might be large, but would be of little value. The draining from the yard should never run to waste, and, unless in extraordinary cases, such as extremely violent rains, this may be easily prevented. An excellent method for this purpose is the sinking a well in the lower part of the yard to fix a pump in; by which the water may be conveyed along a trough to a large heap of marl, turf, chalk, and other appropriate materials, which, by a daily application of this liquor, will be of little less value eventually than a heap of dung of the same size.

If the dung remains under water, putrefaction is stopped; this, therefore, should be carefully guarded against. Stirring the dung should also be avoided, as the oils and alkaline salts are thus carried off into the atmosphere, and it is not merely rottenness that is wanted, and particularly that dry rottenness thus produced, but such as exhibits a fat, oily, mucilaginous appearance. It will be advisable, if practicable, to let it remain in the yard unmoved, till the ground it is destined for is completely ready for its reception. If, for want of room in the yard, it must be carted off into the field, let the litter and the marl be well mixed in filling the cart, and let the whole form, under the shade of trees, if an opportunity be afforded for it, a heap of about four feet in thickness.

The dung raised even by a few sheep in a standing fold, under a shed constructed expressly for the purpose, (for the trouble and expence of one composed of hurdles will overbalance its profits, unless upon a very large scale) is a considerable object, while the sheep under it are at the same time warm and comfortable, instead of being exposed to driving rains and snow.

Animal substances are very far preferable as manures to fossil or vegetable ones. Woollen rags, hog's hair, horn shavings, the offal of butcher's and fishmonger's stalls, may be obtained in large cities, and, whenever reasonably to be procured, should be eagerly caught at. With regard to the dung of animals, that of sheep is unquestionably the best. That of horses fed upon corn and hay is justly preferred to that of fatting cattle, which, however, is greatly superior to that of lean cattle, and particularly of cows, though they may feed upon turnips.

The practice of paring and burning is pronounced by men of great philosophical sagacity and research, and who have justly referred more to practical results than to theoretical reasonings, to be of the most decided advantage in the preparation of land. It may be considered as a practice safe on any soil, as in some it is essentially necessary. That which most of all requires it, and which it is impossible by any other means to pulverize, is what consists of moss, rushes, and all kinds of coarse grass. It should be exercised on moor and heath-fields, on account of the roots of the grass remaining in it, which are very stubborn and durable, and which check the growth of corn, turnips, and other vegetables, by depriving them of a certain portion of nourishment. They serve likewise as a harbour

for worms, the only effectual way to clear the ground from which is to burn it; the old and the young, together with their eggs, being thus destroyed or smothered. The ashes procured by paring and burning will furnish manure for several crops. The lessening of the soil by this husbandry was long apprehended; such a consequence, however, may be safely and positively denied, unless, perhaps, in cases in which the practice is carried to great excess. In poor soils, peat and sedgy bottoms, the process is universally admitted to be a proper one. With respect even to clay lands, it produces not only the common manure found in vegetable ashes, but a substance which acts mechanically to the utmost advantage, loosening and opening the stubborn adhesion of the soil. In loam itself, the ploughing of rough pastures to the depth of eight or nine inches, and burning the whole furrow in heaps of about thirty bushels each, has been attended with most decided and durable improvement; and even though this depth be nearly twenty times the depth of common paring, the soil has not been supposed to be wasted eventually by the practice. Its texture has been rendered less stiff; the redundance of water has been expelled; and the immediate fertility attending this method of treatment fills it speedily with far more vegetable particles than it previously possessed. Sandy grounds are as improveable by this method as those of a different description, and chalk lands, in every part of England, have been so treated, and most profitably been brought into culture. In Gloucestershire, Yorkshire, and Lincolnshire, in Hampshire, Wiltshire, and Kent, the consequent crops of wheat, barley, oats, and sainfoin, have been of sufficient value to buy the land at more than forty years purchase, at a fairly estimated rent, before these improvements were applied. But whatever difference may exist, with respect to the practice on such lands as have been just mentioned, and which is rapidly vanishing before obvious and impressive facts, no one, as already observed, doubts the propriety of it on peat. From the fens of Cambridgeshire to the bogs of Ireland, the moors of the north, or the sedgy bottoms abounding in almost every part of the united kingdom, paring and burning are universally employed, on their being broken up, by men of real experience and observation. The method of doing it by fallow is completely abandoned by all persons of this description, after the most regular and decided experiments of its results. In Cambridgeshire the work is performed by a plough, purposely constructed, and admirably adapted for it, which reduces the expence considerably. With respect to meadow and pasture land, it is performed by what is denominated a breast-plough, which, requiring great strength and labour in its application, much increases the cost. With regard to the general practice, it may be observed, that the heaps should not consist of more than twenty bushels, as, if they are much larger, the turfs will be too much burnt. Their size must be regulated, in a great degree, by the nature of the weather and the thickness of the paring. When the ashes are spread, which should be completed as soon as possible, the land, as is usually the case, should be thinly ploughed. In almost all circumstances, the ashes should be left ploughed in for sowing turnips upon lands burnt in the months of March and April. If potatoes are desired, this preparation is excellently adapted to them, and they should be planted in April on lands burnt in March.

The Culture of Grasses.

A close and sound turf may be considered as the best manure yet discovered, on which account it is justly remarked, that those who have grass can at any time have corn, the reverse of which is by no means true. Excellent grass lands, therefore, are valuable, not only directly, for the food of cattle, but indirectly, as containing ample means of raising grain, never failing, upon being broken up, to produce, for a time, a succession of valuable crops, whether of grain or roots. The small degree of labour and hazard attending the pasture of land recommends it to many; and also the opportunity it supplies of laying out considerable property to great advantage in stock. Lands are preserved by it in good condition, and large estates may be managed under it with peculiar ease.

Grass lands, designed to be cut for hay, are to be distinguished from those on which the herbage is intended to be consumed by cattle on the spot: In fields of the latter kind, properly called pastures, manure is supplied by the cattle; in the others it must be applied artificially, as large crops of hay exhaust the land, and always in proportion to the maturity which the herbage is suffered to attain before cropping, while nothing is

returned to the soil, for all that is thus detached from it. In consequence, moreover, of depasturing lands, the plants, being unable to propagate themselves by seed, do it by root, forming a compact and matted turf, incapable of sending forth strong and powerful stems, to form a good crop of hay, but abounding in slender and delicate shoots, such as the closeness of the turf will alone permit to pass, and which constitute a most nourishing and pleasing food for cattle. These two modes of employing land therefore should not be intermixed. What has for some time been applied to either purpose should, by all means, be permitted to remain so; and to attempt to alternate the application of grass lands between pasture and cropping, is an effectual method of completely defeating both objects.

The difficulty of restoring old, rich, and clean pastures to their original state, after their being broken up, should ever prevent their being so, unless in very extraordinary cases. In common times they can be applied to no better purpose than their actual one: whenever it is expedient to direct them to the raising of grain, they will be certain to produce it in immense abundance.

With respect to the improvement of which grass lands are generally susceptible, those, of course, should in the first instance be applied to them, which are connected with draining and inclosure, which happily coincide with each other, as the ditch serves at once for dividing and defending the land, and for clearing off the redundant moisture. Irrigation also, which, as well indeed as the last-mentioned topics, has been already adverted to, from its obvious and admirable utility to pasture, will derive every attention in this connection. In spring a heavy wooden roller should be applied, when the weather is moist, as it will then make the greater impression. The roots of the plants will thus be fixed in the soil. The mould will be crushed, and the worm-casts levelled by this practice; and the ground is prepared by it for the application of the scythe, which will, in consequence of this operation, cut deeper, and with more facility.

The stocking of poor pastures with sheep, rather than black cattle, is of particular consequence to their improvement, and the perseverance in this practice for years, the sheep being folded upon the spot, has been more recruiting to poor soils, than any other practice. A habit of matting its roots is given to the grass by the close bite of these animals, and a growth of delicate herbage is promoted. Weeds are likewise cleared by sheep, as every thing young and tender (even heath and broom) is readily eaten by them. By means also of the dung, necessarily arising, an amelioration of the soil as well as produce takes place, of extreme and surprising importance. The sweetness of the feed on the downs of Wiltshire arises, not so much from any natural and characteristic excellence of the grass grown on them, as from its being kept close, and eaten as rapidly as it vegetates. It has been remarked, that, on certain poor soils, it requires much more time to produce the second inch of vegetation than the first, making allowance for the fuller developement and size accompanying the second; a circumstance indicating that the preference should in such cases be given to the feeding by sheep rather than by cattle. The former remarks, however, on this subject, concerning the inapplicability of land thus depastured, for rearing crops of hay, must never be forgotten.

Quicklime, spread in powder over the surface of pasture lands, will scarcely fail to improve, not only the poor, but the more valuable ones. The moss plants, which are so particularly pernicious, are thus destroyed, and converted into valuable manure. Upon impoverished and worn-out lands, about 270 bushels per acre, on the sward, in the summer, will be found of great and durable efficacy in cleaning and improving them. Mixing lime with earth taken from ditches or ponds is superior to using it alone, and, as a general rule, double the quantity of earth should be mixed with that of lime. The requisite proportions vary, however, with the nature of the soils; but are easily ascertained by attentive workmen.

Paring and burning may be applied to pasture with great success in a partial manner, by grubbing up rushes and bushes with which it may be encumbered, burning them after they are dried, and before the autumnal rains come on spreading their ashes on the surface. In some instances this husbandry may be successfully exercised on pasture over the whole surface, as particularly on a poor worn out ley; which, by such a process, attended with the harrowing in of white clover, and several other grass seeds, at the time of spreading the ashes, has been improved into a very fine meadow. Where suitable, such a practice may be regarded as one of the cheapest of all improvements.

From whatever cause land may be overrun with moos plants, or covered with fern, rushes, and ant-hills, it should be subjected for some time to the plough, as no other method is equally useful to prepare for permanently ameliorating its pasture.

To prepare arable land for grass, it must be cleaned from weeds, and well manured, just in the same manner as that which is required for a crop of grain. Excepting upon stiff clays, the most eligible preparation for grass is a crop of turnips, consumed by cattle in the field; the ground being thus at once manured and cleaned. Where lands are broken up expressly for the purpose of improving the pasture, the turnips scarcely fail to succeed, through the manure afforded so abundantly by the fresh turf; and the cattle deriving, from the abundant crop consequent on this circumstance, a plentiful food, are thus enabled, the more extensively, to improve the soil by dung. On the clay land, the soil should be very liberally manured in spring or autumn, it ought to be ploughed once in autumn, and three or four times more in summer, previously to the period of sowing the seeds, which should take place in August. As to the much agitated question of sowing grass seeds with or without a crop of corn, it may be observed, that it is impossible for lands intended for grass crops, or meadow, to possess too high a state of richness, and that, after the soil is improved with a view to its permanent fertility in grass, to weaken it by a crop of corn appears little better than blind or infatuated counteraction. If, however, the practice be persevered in, which has so generally been followed in this respect, barley should be the grain preferred, as springing up with a slight stalk, and not overshadowing and smothering the grass plants, and also as being the incumbrance to those plants more speedily removed than any other.

Whether the grass seeds be sown in August after a fallow, or with corn in spring, all trampling by horses or cattle should be effectually prevented. Every thing, therefore, should be kept out from it, both during autumn and winter. Not only is the tender soil, which is extremely susceptible of injury, thus secured from it, but the pasturage in the spring is of proportionally more value for not having been eaten off in autumn, and affords a most valuable early bite for the ewes and lambs.

The proper treatment of leys during the first year is, to feed them with sheep, unless, after a crop of hay be taken from them, vast quantities of manure be spread over their surface.

The chief food of cattle consisting of grasses, their importance is as obvious as it is great, and the distinguishing and selecting them cannot be too fully attended to. By this care the best grasses, and in the greatest abundance that the land admits of, are secured; while, for want of this attention, pastures are either filled with weeds, or bad and inappropriate grasses. The number of grasses fit, or at least necessary, for the purposes of culture, is but small, scarcely exceeding half a score, and by the careful separation and sowing of the seeds of these, the husbandman would soon be enabled to accommodate the varieties of his soil, each with the herbage best adapted to it, the advantage of which would infinitely exceed the trouble necessary for its accomplishment. Were a great variety of grain to be sown in the same inclosure, the absurdity would be universally ridiculed; and scarcely less absurd and ridiculous is the common practice of indiscriminately sowing grass seeds from the foul hay rack, including a mixture of almost every species of grass seed and rubbish.

The species of grass appropriated to any particular soil or application being determined upon, its seeds cannot be sown too plentifully, and no economy less deserving the name can possibly exist, than the being sparing of grass seeds. The seeds of grain may easily be sown too thickly; but with respect to those of grass, it is scarcely capable of occurring. The smaller the stem, the more acceptable it is to cattle; and when the seeds, particularly of some grasses, are thinly scattered, their stems tend, as it is called, to wood.

The most valuable grass to be cut green, for summer's food, is red clover, which also is an admirable preparation for wheat. To have it in perfection, the weeds must be cleared, and the land harrowed as finely as possible. The surface should also be smoothed with a light roller. The seeds should likewise be well covered with earth, as should all small seeds, notwithstanding the common opinion to the contrary. From the middle of April to that of May is the proper season for sowing it. Although it will last three years, if cut down green, the safest course is to let it stand but one. It is luxuriant upon a rich soil, whether of clay, loam, or gravel, and will grow even upon a moor. For a wet soil it is totally unfit.

It may be sown with grain with less impropriety than perhaps any other grass, and particularly with flax. When a land, left unploughed, spontaneously produces this plant, the soil may decidedly be pronounced good.

Those who lay down land permanently to grass may best depend on white, or Dutch, clover, for all rich and dry loams and sands, and for rich clays that have been properly drained.

Rye grass will flourish on any land but stiff clays. It is well adapted for permanent pasture, and, if properly managed, is one of the best spring grasses. There are few so early, or more palatable and nutritive to cattle. It is less subject to injury in critical hay seasons than any other, and the seeds of none are collected with greater facility. It should be cut for hay some time previously to its being ripe, as the stalks will otherwise be converted into a species of straw, and its nutritive qualities be proportionably weakened.

Sainfoin is preferred by many agriculturists to clover, as less likely to injure cattle when they eat it green, producing larger crops, making better hay, and continuing four times longer in the ground. It is several years in arriving at its full strength. The quantity of milk yielded by means of it from cows is nearly double of what is produced by any other green food, and the quality also of the milk is proportionally better. It is much cultivated on chalky soils, and succeeds best where its roots run deep. Cold and wet clay is extremely ill adapted for it, and the dryness of land is of more consequence to its growth than even the richness of it. It is best cultivated by the drill husbandry, after repeated ploughing, harrowing, and rolling; and while care is taken not to leave the seeds uncovered, they must also not be buried deeper than about an inch. They should be sowed in the latter end of March. An acre of very ordinary land will maintain four cows for eight months, and afford the greatest part of their food in hay for the rest of the year.

Lucerne remains at least above twelve years producing very large crops, and yielding the most excellent hay, to the amount of about seven tons per acre. It has obtained the highest praises from all agricultural writers. With a view to its successful cultivation, the soil must be kept open and free from weeds, which is most effectually done by horse-hoeing. It is transplanted with extreme advantage, if the tap root be cut off, by which it is fitted for a shallow soil, and its roots shoot out laterally and near the surface. The culture of this plant is a principal distinction of French husbandry, and is in that country a source of almost uniform profit. The best preparation for it is a turnip or cabbage crop. No manure should be allowed after the sowing till the crop is two years old. Its improving effect upon the soil is particularly great.

Burnet is a grass peculiarly adapted to poor land, and is so hardy as to flourish when all other vegetation fails. Its cultivation is not hazardous or expensive. It is best sown in the beginning of July. It affords rich pleasant milk, and in great plenty. For moist loams and clays there cannot be a better grass than the meadow fox-tail, which is not only early, but remains for nine or ten years, and is little injured by frost.

To these remarks on a few of the grasses it may be added, that, in connection with soils, the principal grass plants have been thus arranged by one of the most distinguished agriculturists of the day.

Clay.	*Loam.*	*Sand.*
Cow grass	White clover	White clover
Cock's-foot	Rye	Rye
Dog's-tail	York white	York white
Fescue	Fescue	Yarrow
Fox-tail	Fox-tail	Burnet
Oat grass	Dog's-tail	Trefoil
Trefoil	Poa	Rib
York white	Timothy	
Timothy	Yarrow	
	Lucerne	

Chalk.	*Peat.*
Yarrow	White clover
Burnet	Dog's tail
Trefoil	Cock's-foot
White clover	Rib
Sainfoin	York white
	Rye
	Fox-tail
	Fescue
	Timothy.

Instruments and Operations of Husbandry.

The instruments used in husbandry are so numerous, and, under the same denomination, often so differently constructed, with a view to varieties of the same operation, that it would be impossible, in a sketch like the present, to detail their structure and application. In the process for which they are respectively intended, every agriculturist will of course avail

himself of those, the utility of which is best decided by experience.

Ploughing.

In almost all lands there is a fixed depth for the plough to go to, which is the stratum between the fertile and unfertile moulds. No soil should be ploughed beyond this bottom, or sole, which is the preservative on which the top layer should rest, and by which the manure laid upon the ground is prevented from losing its effect. In fallowing land, therefore, the plough may go as deep as the fertile soil will allow, as also in breaking up land without paring and burning. When land is pared and burnt, it ought to be ploughed in small furrows, and not so deep, as this depth of furrow would hazard the loss of the ashes for the immediate, and indeed for the subsequent, crops. Where the sods are burnt in small heaps, and by slow fires, and the land ploughed shallow for the first time, and successively deeper and deeper, poor land will be more effectually benefited from itself than by any other mode; and in proportion as land can be made to maintain or improve itself, the benefit to the farmer is obvious.

Instead of ploughing stubble into the land, it is far better to move the stubble, and even to harrow the land before it is fallowed. In soil of a poor quality, a certain proportion should be observed between the depth of ploughing and the quantity of manure usually spread, which on better soils might be safely disregarded. There are few, which it is not requisite to plough to the depth of six inches; and for many, the depth of ten is by no means too great. Once in twelve or eighteen months it is highly desirable to plough to the full depth, while in the interval shallower tillage will be preferable to deep working, for wheat particularly, which is best promoted by a firm bottom. A ploughing before harvest is of extreme consequence in fallowing, with respect to which seasonableness is of more consequence than the number of earths given. When fallows are called for, they should be attended with an observant eye, and be kept clean, whatever other business may press upon the husbandman's attention. On a well-managed farm, servants and cattle will be kept sufficient for every necessary operation. The practice of fallows, however, is now abandoned in a variety of cases in which they were formerly deemed absolutely indispensable, and the well-informed agriculturist will seldom have recourse to them after his first year.

Harrowing is not only necessary for covering the seed, but also for preparing the land for its reception. The same instruments, whatever be their form, cannot answer the different purposes of this operation upon all soils, whether firm or loose, and rough or smooth. For every purpose, however, and of whatever size, they should be so constructed, that no tooth can follow the track of another, and that every one should be constantly kept acting. The practice is best performed by harrowing a square piece of land at once, so that the instrument may be lifted at the corner, and the refuse stuff left there. The following harrows will thus have an opportunity of passing over every part of the land, and it will be completely cleaned from couch grass and all noxious weeds.

Till of late years the practice of rolling was but little used, or even known, and it is in many places exercised so slightly, as to be of little service. Its utility, when it is exercised as it ought to be, consists in rendering a loose soil more compact and solid, which, by making the earth adhere to the roots of plants, cherishes their growth. No roller that can be drawn by two, or even by four, horses, will carry this effect too far. By rolling, moreover, the moisture of the earth is kept more in, and, in a dry season, this circumstance may reasonably be presumed sometimes to constitute the difference between a good and a bad crop. The common practice of breaking clods by means of mallets may judiciously be superseded by the roller, preceded for a day or two by harrowing. When firm and tough clay clods are to be broken, a large and heavy roller will be required for this purpose, with circles of iron of the depth of six or seven inches, which will completely reduce the most stubborn clods, and, from its decided usefulness, must by no means be regarded as a refinement in husbandry, productive of expense, without ample corresponding advantage. With respect to grass lands, the mowing for hay is extremely facilitated by the practice of rolling.

The practice of scarifying grass lands is used by a variety of persons, and is directly opposite to that of rolling them in its principle and effect. For this purpose a plough, consisting only of four coulters, or narrow teeth, is employed; and it is asserted that the crops of hay are considerably increased by the loosening of the earth occasioned by this process, the roots acquiring the power of fresh vegetation, while rolling is stated to increase the te-

nacity of many pastures, in which it ought rather to be diminished. Previously to the manuring of grass land it is observed to be particularly beneficial, as whatever it be that is spread over the ground finds, in consequence of this method, more rapid access to the roots, and a smaller quantity is remarked to answer the end proposed than a considerably larger one without this practice. The operation may undoubtedly be beneficial in various instances and soils, and experiments indeed have evinced that it is so. The use of the roller, however, upon grass lands of a certain description, will be admitted to be preferable; and with regard to arable land, this new process by no means interferes with the application of the roller, for all the purposes which have been mentioned.

Drill Husbandry.

The system of drill husbandry has been long known to be extremely preferable on sandy soils and dry loams, and in Norfolk particularly it made a rapid and extensive progress upon such lands. It has latterly been introduced on the strong soils of Suffolk. The objects of this husbandry are, the promotion of the growth of plants by hoeing, and the saving of seed; objects, it will be universally admitted, of great importance. It was well known, that in gardens the hoeing and transplantation of vegetables often doubled their vigour: analogy therefore naturally led to the conclusion, that a similar result would occur from the same management of arable lands, and experience has decided both the practicability and the advantage of it. Land sowed with wheat, however well prepared and finished it may be in the autumn, sinks in winter, so that in the spring it possesses too great tenacity to admit the free extension of the roots for the collection of nourishment, and stands in extreme need of ploughing and hoeing to counteract these effects. Grain sown before winter, therefore, requires the process of hoeing inexpressibly more than what is sown in the spring; the land in the latter case not having had the same time to harden, nor to produce many weeds by exposure to the winter snow and rain.

As the vigour of the plants upon the drill system is very considerably increased, the land must be sowed much thinner than in the old practice; a circumstance, which, in unreflecting minds, has operated as a considerable objection, it appearing at the first view, which on such is not only strong, but often indelibly impressive, that the vacant spots are completely lost or wasted. In the common practice, however, even in the most productive lands, the seeds, though very thickly sown, produce each but one or two ears, whereas two or three are universally produced by each in the latter mode, and sometimes a single one will produce 18 or 20. In the old method, there being by far more plants than nourishment, many must perish without attaining maturity, and many of the remainder can exist only in a languid and drooping state; whereas in the other method all have as much nutriment as they require, and though comparatively few, being far more vigorous in their vegetation, they afford a larger produce than the numerous but sickly plants cultivated in the ordinary method.

For the application of this new mode, however, it is expedient that land should have been brought into good tilth by the old method, which being done, it should be so thinly sown as to leave sufficient room for the plants to extend themselves. It must be divided for this purpose into rows, 30 inches distant from each other, which will give an interval of two feet between the rows, every plant thereby having ample room to extend its roots and collect its food. In such considerable intervals, also, the earth may be hoed round the plants without the hazard of injury to them. The first hoeing should be applied when the wheat is in leaf, before winter, and is designed to draw off the wet, and dispose the earth to be mellowed by frost. The second, after the hard frosts are passed, is calculated for making the plants branch freely. The third may be very slight, and should be given when the ears begin to appear. The last should be given when the wheat is in bloom, and is of the greatest importance, as it makes the ears fill at the extremities, and increases the size of the grain. In the middle of the intervals a deep furrow must be traced, and the earth be thrown to the right and left on the foot of the plants. By the careful application of the earth in this manner the plants are supported, and prevented from being laid, and the ground is prepared for the next sowing, in which the seed is to be put in the middle of the ground that formed the intervals.

The practice of hoeing may take place at almost any time in light and dry soils; but on strong and clay ones, in which

the extremes of wet and dry are particularly inimical to vegetation, the seasons for its exercise are often short and critical.

As vigorous plants, such as are produced by this system, require a longer period for attaining maturity, the corn thus cultivated must be sown earlier than in the usual mode. The intervals are usually prepared for sowing again, by placing some well-rotted dung in the deep furrows made in the middle of them, and this dung must be covered by the earth before thrown towards the rows of wheat. This should be performed immediately after harvest, that, before the rows are sowed, there may be time for slightly stirring the land. The intervals of the second year occupy the place taken up by the stubble of the preceding.

The banishment of the plough in spring, to as great a degree as possible, has taken place, in consequence of this most useful and happy innovation. All peas and beans, barley and oats, not only may be put in on an autumnal ploughing, but actually are so in many parts of the country (especially in Suffolk,) the stiches in this ploughing being carefully thrown to the precise breadth, suited to the intention of the farmer, whether to use only one movement of the drill, or what is usually denominated a bout of it; on which subject opinions differ. By the winter frosts a friability is given to the surface of the soil, so great, that very early in the spring, after one scarifying and harrowing, the corn may be drilled, and without a horse-foot treading any where but in the stich furrows, where it can do no injury. Instead of losing this admirable gift of the atmosphere (which cannot be renewed,) as was done by the former practice of at least two spring ploughings, it is thus completely preserved, and the delay, expense, and vexation, occasioned to the farmer, by the succession of rains and north-easterly winds, giving the dreadful alternative of mire and clods, are wholly avoided.

From a comparative estimate of the profits attending the different modes of husbandry, that of the new is stated, after various experiments, to be very nearly in the proportion of three to two: and making the utmost allowance for the influence, by which the sanguine temperament of the partizan will interfere with the dispassionate calculations of philosophy, the advantage on the side of profit is indisputably and greatly with the modern system. It is also to be observed, that most of the accidents attending crops of wheat originate in their being late sown, which, on the old plan, is unavoidable; whereas, in the new method, the farmer may plough the furrows for the next crop as soon as ever the first is removed. The ground may be ploughed dry, and may be drilled wet. The seed, moreover, is not planted under the furrows, but at the precisely proper depth. The seed has all the advantage of early sowing, therefore, and the crop is more certain than by any other mode. The land, also, is much less exhausted by this method, the weeds being completely destroyed by the hoe, and none of the plants existing to draw nutriment from the ground but what attain their full maturity; whereas in the usual practice seeds are permitted inevitably to impoverish, and three-fourths of the plants themselves, after having derived a certain and a considerable portion of vegetable food from the soil, perish abortively. The state of the land, therefore, must necessarily and obviously be left far better by the new mode than by the old.

The practice of drill-husbandry has been justly remarked to be the management of the garden brought into the field; and the grand question relating to it is, whether the extraordinary expense of this finer cultivation be compensated by the superior quality or abundance of its crop? which the most sagacious and experienced judges have determined in the affirmative.

Even admitting, for a moment, after all, that the practice is not, on the whole, superior, or equal, to the old mode, its introduction has at least been highly serviceable in correcting and refining the old method of cultivation, and some of the reputation of the new one may undoubtedly be allowed to have arisen from a comparison with slovenly and defective methods upon the old plan.

With regard to white crops, there are many practitioners of liberality and sense who reject this practice, although, with respect to potatoes, cabbages, beans, and often turnips also, it is admitted by them to be unexceptionable. On a soil, however, in which the drill machine can move with freedom, there appears no reason, and it may be almost said no excuse, for the rejection of the modern system, which, indeed, however recently it may have been introduced into this country, is practised in every part of China, and is used also by the inhabitants of the Carnatic, and, from the decided aversion of these nations to innovation, may naturally

be supposed to have been their practice for a vast succession of ages. Tobacco, cotton, and the castor-oil plant, are cultivated by it, as well as every species of grain.

The Culture of Grain and Roots.

Of the various plants raised for the nourishment of man, wheat is of the chief importance. To prevent the disease so fatal to this vegetable, called the smut, steeping its seed from twelve to twenty-four hours in a ley of wood ashes, in lime water, and in a solution of arsenic, is completely efficacious, even although it should have been extremely affected by the disease. A less time is insufficient. On cold, wet, and backward soils, the best season for putting this grain into the earth is September, particularly if the weather be rainy, as wheat should never be sown in a dry season. On dry and warm soils the sowing may be best postponed till October. In proportion to the earliness of the sowing, a less quantity of seed is sufficient. The best preparation for it is by beans. Clover forms also an excellent preparation for it: and on a farm dry enough for turnips, and rich enough for wheat, the Norfolk practice of turnips, barley, clover, and wheat, is perhaps the most eligible that can be adopted.

By the dibbling of wheat, for a fortnight before which the land must be ploughed, and rolled down with a heavy roller, the seed is deposited in the centre of the flag, and the regular treading which the land receives presses down the furrows, and gives it a most valuable degree of firmness. The chief attention required in dibbling is, to make the holes deep enough, and to see that the children drop the seed equally, without scattering. After this dropping is completed, bush-harrowing follows. The quantity of seed should be about six pecks in two rows in a flag. If the drill-machine be used, the preparation of the land by ploughing, harrowing, and rolling, must be extremely accurate, whether for one stroke of the machine, or for a bout of it, and the quantity of seed should be the same as that used in dibbling. In February, slight dressings are with great advantage spread over the green crop of this grain; and if the farmer has his choice for this purpose, he can never hesitate about taking them from dung; as dungs of all sorts are excellent, and no other manures, like these, are universally applicable. In the drill-husbandry, the practice of hoeing is of the first importance, and has been already mentioned. If horse-hoeing be not employed, the hand-hoe may be used to great advantage, and should be performed, first, early in March, and the second time in the beginning of April. A scarifier is by many employed instead of the hoe, with the same object and effect Whatever the operation, employed with this view, may be, the bottom should, with respect to wheat, be left firm and untouched. This is of particular importance.

A mild and open winter is far from being favourable to this grain, pushing it forward with too rapid vegetation, and also cherishing those weeds which become its most injurious enemies. No weather is so injurious to wheat in the ground as wet. If, however, it have a good blooming time, though the rest of the summer, both before and after this period, may be unkindly, little apprehension for the crop need be entertained from any state of the weather.

If wheat be attacked by mildew, which is most likely to occur in the month of July, the only effectual application is the sickle, which ought not to be delayed for a moment, though the ear be perfectly green.

Barley requires a mellow soil, and when sown upon clay, therefore, extraordinary care is required to stir the land immediately after the removal of the previous crop; and, with this view, the practice of rib-ploughing, which exposes the greatest possible quantity of surface to the air and frost, has been employed by many. This object should, at all events, be gained, whichever method be adopted for it, of the many which have been suggested, and are indeed practised. Scarification, with Mr. Cooke's machine for this purpose, instead of ploughing, is found to be an excellent method. In proportion to the tenaciousness of the soil must be the extent of this operation, which is easily dispatched, even when repeated, leaving the lands, or stiches, in excellent order for the drill-machine to advance and perfect its work.

The proper season for getting barley into the ground is March. The most useful preparation for it is by turnips. To have the land dry for sowing is of more consequence for this grain, than it is for almost any other. It should always follow either an ameliorating crop or a fallow, and in many cases it should be followed by clover. The quantity of seed

barley should be increased as the season advances, as early sown crops have more time to tiller than later ones; and in the same proportion, the importance of the drill husbandry with regard to this article increases; as, if sown in the latter end of February, in the broadcast method, it would get the start of weeds, which, if it be sown early in April, would extremely annoy it, according to the old mode, but by the hoeing practice may be easily removed.

Oats should never be sown after other corn crops (as the land is by this practice too much exhausted,) and should receive the same preparation as barley: a circumstance often not sufficiently attended to. Warm, forward sands yield as great a quantity of barley as of oats, and should, therefore, be applied to the culture of the former, as generally yielding a better price. Upon various other soils, however, the produce of oats will be in considerably greater proportion than that of barley, and by superior quantity more than compensate for being sold at the smaller price. To relieve the business of the succeeding months, oats may sometimes be sown in January; without this view, however, February is preferable. The land should have been ploughed in October. Six bushels per acre may be sown in broadcast, and on poor soils even eight, to great advantage: the crop being, by thick sowing, several days sooner ripe, and the idea of saving seed with respect to this grain not being an object worth any particular attention. In the drill husbandry five bushels per acre are sufficient, and they should be horse-hoed early in the month of May.

Peas are extremely ameliorating to the soil, and may, therefore, with very great advantage, be substituted in tillage for white corn, a succession of which is peculiarly impoverishing. They should, however, not be sown on lands negligently prepared, as is too commonly done; and indeed the maxim cannot be too much attended to, with respect to grain, that none should be sown but on lands in really good order, with respect to heart, cleanness from weeds, and well-finished tilth. The uncertainty generally ascribed to this crop is to be attributed in a great degree to a neglect of these circumstances. At the same time, however, it is not meant to be asserted, that for all grain the preparation should be equally high and finished. The earlier peas are sown, the better they will thrive, and the more easily they will be moved off the ground in due time for turnips, a circumstance of particular importance. February is the proper month for their being sown. Early peas will seldom prove beneficial upon wet soils, and should be cultivated only on dry ones, upon sands, dry sandy loams, gravels, and chalks. The broadcast method should be most clearly rejected in relation to them. The only question is between drilling and dibbling them. On a ley, the latter practice cannot be too decidedly adopted. Put in on a layer, they do not want manure, which will often make them run to long straw, a circumstance unfavourable to podding, and likewise encourages weeds, which, in the infant stage of the growth of peas, cannot be extirpated without danger. If the land be in good heart, therefore, as it ought to be, dung may be applied with much more advantage to other crops; and being an article for which the farmer has, perhaps in all cases, a greater demand than he can supply, should be used with economy, and only where it is sure to answer best. The proper quantity of seeds to be applied in the drill-husbandry, in equally distant rows, about one foot asunder, is seven pecks per acre. It is a judicious and valuable observation, the result of long experience, that peas should not be sown above once in about ten years, being not found to succeed, if sown oftener.

Beans, where the land is proper for them, deserve from the farmer every attention, constituting one of the surest funds of profit. He is enabled by them to lessen, if not absolutely explode, the practice of fallowing. When cultivated, however, with a view of substituting them in the room of fallow, drilling or dibbling must be uniformly employed, so as to admit the plough between their rows, as no hand-work will sufficiently pulverize the lands for the purpose, without extreme expence. Dibbling, when well performed, with respect to beans, is an admirable method. The difficulty, however, of procuring it to be well done, must be considered as no trifling objection to it. Beans are too often imperfectly delivered by the various drill-machines employed. On the other hand, however, the practice is less expensive than dibbling, and the seed is more surely put in to the desired depth, so that, on the whole, the drilling method seems preferable to that by dibbling. It is a point on which different circumstances will safely and judiciously lead to different conclusions; and soil, season, dependance upon servants, together with

other considerations, will be resorted to, previously to the decision upon either of these methods. The common little horse-bean has the advantage of being more marketable than any other. Beans thrive upon light loams better than has been generally imagined. The soils, however, generally applied to their culture, are all the strong and heavy ones. Wherever they can be cultivated, the farmer ought to have them. They do not exhaust the soil. Wheat is prepared for by them, perhaps, better than by any other mode. They preserve their upright attitude to the latest period, admitting of horse-hoeing to the very last. The ground is well shaded by them from the sun: and, if they are harvested favourably, their straw is valuable, and, at all events, may be converted into admirable dung. By a bad crop of peas, the land is often filled with weeds; but though a crop of beans should be extremely bad, the land may nevertheless be in the highest state of cleanness. The quantity of seed differs according to the variety of the grain. About two bushels of the horse-beans per acre, in rows equi-distant, at eighteen inches, is a proper allowance, and February is the month in which they should be put in.

Buck-wheat is known to a vast majority of the farmers of this kingdom only by name. It has, however, numerous excellencies, is of an enriching nature, and prepares well for wheat or any other crop. One bushel of seed is sufficient to sow an acre, which is only about the fourth part of the expense of seed barley. It is sold at the same price as barley, and is equal to it for the fatting of hogs and poultry. The end of May is the proper season for its being sown, and grass seeds may be sown with it, if the practice should be thought in any instance eligible, with more advantage than with any other grain, unless barley may be excepted. Buck-wheat may be sown even so late as the first week in July, a circumstance by which the period of tillage is considerably protracted, and an a meliorating crop may thus be produced, after the usual period has, from any unavoidable or casual occurrence, been neglected.

Potatoes form a most important article of food, both for the human species and for cattle, and are an inestimable substitute for bread formed of grain, the best resource in periods of scarcity of wheat; and, happily, when the crops of grain fail, through redundant moisture, the potatoe is far from being equally injured, and sometimes is even benefited by the wet season. The choice of soil for the culture of this root is of prime importance. Potatoes never make palatable nourishment for man, if grown in a clay soil, or in rank, black loam, although in these circumstances they are well fitted for cattle, and relished by them, and also produced in great abundance. They grow to perfection for human food in gravelly and sandy soils. The drill should be universally preferred for their cultivation. In September, or October, the field intended for them should have successively a rousing furrow, a cross braking, and the operation of the cleaning harrow; and being formed into three-feet ridges, should remain in that state till April, which is the proper season for planting this root. After cross braking them, to raise in a small degree the furrows, well-rotted horse-dung should be laid along them, on which the roots should be laid at eight inches distance. The plough should then pass once round every row, to cover them. As soon as they appear above ground, the plough should be passed round them a second time, laying on the plants about an inch, or somewhat more, of mould, in addition. When they have attained the height of six inches, the plough should go twice along the middle of each interval, in opposite directions, laying earth first to one row, and then to another; and, to apply it more closely to the roots, a spade should afterwards be used to cover four inches of the plants, and bury all the weeds. The weeds which arise afterwards must be extirpated by the hand, as the hoes would go too deep, and damage the roots of the plants. From ten to fifteen bushels will be sufficient to plant an acre, the produce of which may probably be three hundred bushels. Sets should be cut for some few before they are planted, with at least one eye to each, and not in very small pieces, and the depredations of the grub upon them may be effectually prevented by scattering on the surface of the land about two bushels per acre of lime, fresh slaked. The most certain method of taking them up is, to plough once round every row, at the distance of four inches, after which they may easily be raised, by a three-clawed fork, rather than by a spade, and scarcely a single one will by this practice be left in the ground. They may with care be preserved till the ensuing crop, particularly by the allowance necessary till April being closely covered in the barn with dry and pressed down straw, while the remainder for the ensuing part

of the year is buried in a dry cave, mixed with the husks of dried oats, sand, or leaves, especially if a hay or corn-stack is erected over it.

Potatoes are subject to a disease called the curl, which has drawn the attention of sagacious and experienced men, and suggested, in consequence, a great variety of opinions on its cause and remedy. Some kinds of this root, however, it is almost unanimously agreed, are less susceptible of the disease than others, and the old red, the golden dun, and the long dun, are the least of all so. One or more of the following circumstances may be most probably considered as causing it; frost, insects, the planting from sets of unripe and large potatoes, the planting in old and exhausted grounds, and too near the surface, or the small shoots of the sets being broken off before planting. Where certainty on any interesting subject cannot be obtained, the hints of the judicious are always desirable. The methods most successfully exercised for the prevention of the curl are, to cut the sets from smooth ripe potatoes, of the middle size, which have been kept particularly dry, to guard against the rubbing off the first shoots, and to plant them rather deeply in fresh earth, with a mixture of quick lime.

No plant thrives better even in the coldest part of this island than the turnip, and none are more advantageous to the soil. Its introduction was an improvement of the most valuable nature. There is no soil which will not produce it, when previously prepared for it by art; but the gravelly one is best of all adapted to it. No root requires a finer mould than the turnip, and with a view to this object, the land intended for it should be exposed to frost by ribbing it after the harvest. The season for sowing must be regulated by the time intended for feeding, the later from the first of June to the end of July, in proportion to the designed protraction of this feeding. The field should be first ploughed by a shallow furrow. Lime, if necessary, should be then harrowed into it. Single furrows, at the interval of three feet, should be drawn, and dung laid in them, which should be then covered by going round it with the plough, and forming the three feet spaces into ridges. Wider rows answer no profitable object, and with straiter ones a horse has not room to walk. Thick sowing is far better than thin, bearing better the depredations of the fly, and forming also a protection against drought. The weeds may, in many cases, be most effectually extirpated by women, without injuring the crop; and the standing turnips should be left at twelve inches distance from each other. On average seasons, with good preparation, the produce from this number per acre may be considered as amounting to 46 tons of valuable nourishment. For preservation they may be stacked with straw; and 42 tons may be thus secured by one load of straw, or of stubble and old haulm. A method preferred by many is that of sowing late crops, even in August, by which a succession of them remains on the field to be consumed on the spot, even so late as the ensuing May, and the advantage of having turnips good till the spring grasses are ready for food, has greatly encouraged this practice. To prevent the devastations of the fly, the most destructive enemy to a crop of turnips, the most effectual method, as little dependance can be placed on steepings, or on fumigations, is to sow the seed at such a season, that they may be well grown before the appearance of the insect; and by well dunging and manuring the ground, to hasten their attainment of the rough leaf, in which the fly does not at all affect them. New seed, it may also be observed, vegetates more rapidly and vigorously than old; and the more healthy and vigorous the plants are, the more likely they are to escape depredation. The sowing of turnips with grain is by many recommended in this connection, and stated to be highly efficacious.

The culture of cabbages for cattle is a subject well meriting the attention of the agriculturist. The cabbage is subject to few diseases, and resists frost more easily than the turnip. It is palatable to cattle, and sooner fills them than carrots or potatoes; and, in every respect but one, cabbages are superior to turnips. On all soils they require manure; whereas, on good land, turnips may be raised without it. Fifty-four tons have been raised upon an acre of ground not worth more than twelve shillings per annum. Some lands have produced sixty-eight. The time of setting them depends on their intended use. If for feeding in November, plants, procured from seed sown in the end of July in the former year, must be set in March or April: if for feeding in March, April, and May, they must be set in the beginning of the preceding July, from seed sown in the previous February. Repeated transplantation may be applied to them with singular advantage. When they are of the large species, four feet by two and a

half are a full distance for them. The best protection for them from the caterpillar, by which these and greens in general are apt particularly to be injured, is to pull off the large under-leaves, (which may be given to cows with great benefit) on which the eggs of those insects are usually deposited. Sowing beans among the cabbages is also considered a most effectual preventive of the nuisance.

Carrots require a deeper soil than any other root, and when the soil does not naturally extend to the depth of twelve inches, equally good throughout, it must be artificially made so for their culture, which may be easily effected by trench-ploughing. Loams and sandy soils are the only ones in which they will flourish, and no dung can be used for them in the year they are sown, as it will inevitably rot them. The ground must be prepared for them by the deepest possible furrows, and, when they are sown, about the beginning of April, it must be smoothed by a brake. In large plots of ground, where horse-hoeing is requisite, three feet should be the distance between the drills. Where an acre or little more only is employed, the interval should not be greater than a foot, and hand-hoeing will be found more convenient, and scarcely attended with greater expense. From six to nine hundred bushels have been produced per acre of this root, where the land has been carefully prepared and attended to. As food for horses, its culture is rapidly spreading. For oxen, milch cows, and pigs, carrots are admirably applicable and nourishing, and, when boiled, turkeys and other poultry are fed on them with great success.

The ease with which parsnips are cultivated, and the great quantity of saccharine and nutritious matter which they contain, in which they are scarcely exceeded by any vegetable whatever, render them well worthy of the attention of the husbandman. Though little used in Britain, they are highly esteemed in many districts of France, in some parts being thought little inferior to wheat as food for man. Cows which are fed with them are stated to give as much milk as they do in the months of summer. All animals eat them with avidity, and in preference to potatoes, and fatten more quickly upon them. In the cultivation of them the seed should be sown in the autumn, immediately after it is reaped. When the seed is put in at this season, the plants will anticipate the growth of weeds in the following spring. Frost never does them any material injury. The best soil for them is a deep, rich loam. Sand is next suitable to them; and in a black, gritty soil they will flourish, but not in gravel or clay. In the deepest earth they are always largest. In an appropriate soil no manure is necessary for them, and a very good crop has been obtained for three years in succession, without using any. The seed should be sown in drills, at the distance of eighteen inches, for the greater convenience of hoeing; and by a second hoeing and a cautious earthing, by which the leaves may not be covered, the crop will be luxuriant. In Jersey, the root has been known and cultivated for several centuries, and is highly valued. It is considered as an excellent preparation for wheat, which, after parsnips, yields an abundant crop without any manure.

The profit of cultivating hemp-seed is by no means small. It requires, however, the best land that can be found on a farm, or which is made such by manuring. A rich, deep, putrid, and friable loam is what it particularly delights in; and in addition to natural richness, forty cubical yards of dung per acre should be supplied. Besides this original cost of land in natural richness and preparation, it is to be considered that hemp returns nothing to the farm yard, while corn will give straw, and the dung hill is improved by green crops. The question concerning the propriety of its cultivation by any individual is not to be determined, therefore, only from the circumstance of any price in the market, but is to be inferred from a view of all its bearings and connections. For many crops, tillage should be given with caution. With hemp such caution is unnecessary, as its rank and luxuriant growth proves fatal to all those weeds, by which corn would not only be injured, but destroyed. From the autumn preceding to the time of sowing hemp, the land should be three or four times ploughed, and be well harrowed to a fine surface. The quantity of dung should be proportioned to the deficiency of the soil; and when the culture is continued from year to year, a plentiful dressing must be every time applied. About twelve pecks should be sown per acre: and as the destruction of weeds in the tillage is here no object, the broadcast method is universally preferable to the drill. It will be ready for pulling in August, or about thirteen weeks after it is sown.

Flax, with due attention, will repay its cultivation; but, generally speaking, in this country the same land and manure

may be more conveniently and profitably applied. Two bushels an acre is the requisite quantity of seed, and the land, if it be not particularly rich by nature, must be rendered so by art, must be worked to a fine surface, and be kept perfectly free from weeds.

The preparation for rape-seed is the same which is necessary for that of turnips. It is a crop subject to great injury, and extremely uncertain. In the conquered countries in the north of France, the practice is to sow it in a seed bed for transplantation, which is begun in October, and if there be no frost in November, is continued through that month, when the plants are about two feet long. Were this operation to take place earlier, they would be more secure from the frost. Dibbling is employed for the purpose, and the plants are set at about the distance of eighteen inches by ten. In a favourable year the profit is considerable, as indeed it ought to be, to compensate for the frequent and inevitable failure attending this cultivation. An indispensable point, in regard to this article, is to catch at opportunities of fine weather, for the purpose of reaping and threshing, which must be done in immediate succession. In reaping, extreme care is requisite, to prevent the shedding of the seed. Both in lifting it from the ground and conveying it to the barn floor, the utmost attention must be applied. As rain, at this critical period, may be considered nearly fatal to this produce, celerity of operation is of the first consequence, and as many assistants as possible should be procured, and not a moment of fine weather should be suffered to pass unimproved.

The cultivation of hops demands a greater capital than that of any other plant. The cost of the first year's preparation and planting will amount to about eighty pounds per acre, and the subsequent annual expense will be little less than half that sum, and after all the expense, preparation, and attention, which may be employed, no crop is more precarious. The serious consideration of a farmer is demanded, before he resolves to introduce this plant where it has not been usually cultivated. And not only the circumstances already mentioned, but that of the accessibility or distance of manure, (for which the largest quantities are called for by hops,) and the fact, that a small solitary hop ground seldom thrives like those which cover a large extent of country, from whatever cause this may proceed, should be fully weighed. Ruin may easily follow the want of adverting to these and other considerations, and they cannot therefore be too strongly impressed on the sanguine adventurer. A flat deep bog, in a sheltered situation, makes an excellent hop soil, constituting, indeed, a natural dung-hill. For the application of such land to hops, the chances are favourable. The best preparation for this plant, when such a spot as this does not occur, is made by two successive crops of turnips or cabbages, fed off by sheep, early enough for the ploughing and planting in March. The plants should be inserted in rows, at eight feet distance from each other, and about six feet from hill to hill. Four fresh cuttings should be planted in each spot which is to form a hill. In April they should be poled, an operation requiring that critical accuracy, which, depending on changeable and casual circumstances, can be derived only from experience. The binds must next be tied to the poles. The superfluous vines must be pruned about midsummer, and are useful food for cows. September is the month for pulling them. But the management of hops is a subject most operose and delicate, requiring extreme experience, attention, and dexterity; and the details of which would, if extended only equally to its importance, occupy bulky volumes.

Course of Crops.

No subject of greater importance has been treated by modern writers on husbandry, than the succession of crops. Before the present reign, although a considerable number of writers on agriculture existed, this topic was little treated, and by many scarcely adverted to. It has at length obtained something approaching to that attention which it merits. The main principles upon which all practices on this subject proceed are, that some crops are more exhausting than others: that some, although of a very impoverishing character, yet, by being consumed on the farm, return to it as much as they deducted originally from it, and, perhaps, even more, that some admit profitable tillage and accurate cleaning, during their growth; while by others the land is almost unavoidably rendered foul by weeds, is exhausted without return, and, when they are applied in succession, will be extremely and fatally impoverished. By experience, much is found to depend on a certain arrangement of crops of these different and opposite characters; and in no

one circumstance is the theory or practice of husbandry, in the present day, so materially advanced as in relation to this subject. Unless this department be well understood, the efforts of the farmer in others are either abortive or injurious. An important difference is observable between culmiferous and leguminous plants, or those which are cultivated for their seed, and such as are raised for their roots. The former bind the soil, while the latter uniformly give it openness and freedom. The former also are decidedly more exhausting, though unquestionably in themselves the most profitable. No soil can bear them in long and uninterrupted succession. And, on the other hand, without the interposition of them among leguminous crops, the soil in which the latter grow would by their loosening quality become deficient in the tenacity which is necessary for vegetation. Some crops are rendered valuable chiefly from their preparation for others, that are more valuable, of a different kind. The husbandmen of a former age sowed frequently in succession that species of grain which they wished to possess abundantly; whereas, by this practice their object was often, at length, completely defeated. And if wheat, oats, or barley, were for a certain period sown in the same field, the land would eventually, and that in no long time, scarcely return the seed which was put into it.

That rotation is admitted to be best, which enriches the land with abundant manure, preserves it best from weeds, pulverizes the soil most effectually when it is too tenacious, and binds it most completely, where it is naturally too open. As a general rule, those who are engaged in agriculture cannot, with a view to these purposes, have the importance of providing food for large quantities of cattle too repeatedly and emphatically recommended to them. Indeed, by attending to this circumstance, larger quantities of grain are produced than by any other mode, while that produce of the land, which consists of milk, butter, cheese, butcher's meat, and other articles connected with cattle, is nearly so much clear gain. Grass prepares a turf, which, when broken up, constitutes the most valuable of all known manures. Turnips, cabbages, beans, peas, and a variety of other similar food for cattle, supply admirable opportunities for cleaning and pulverizing the soil by repeated hoeings; the close covering which they bestow on the land smothers those weeds which the hoe does not destroy, and they leave the land, besides, in a state of increased and great fertility. Certain exceptions to the necessity of rearing cattle may undoubtedly occur, as, near towns and cities, the easy accessibility of dung will supersede very considerable preparation of it on the premises. Lands also may possibly be so rich as to require neither cattle nor sheep, and like some which are said to lie near the river Garonne, in France, might produce even hemp or wheat in perpetuity. Certain crops, moreover, may happen to be in such particular demand, as to make it desirable to cultivate them by fallow, and not for cattle or sheep. These exceptions can never interfere with the general rule, as such, that that farm will be most productive and profitable, in respect to grain, on which is kept the greatest quantity of sheep and cattle. Two crops of white corn ought never to be produced from a field in immediate succession. In reference to several varieties of soil, it may be useful to give a succession of crops, which has been recommended by a gentleman of considerable judgment and experience. It should be observed, that on this plan the crops must be all particularly well hoed, and kept properly clean; and that the turnips, peas, and beans, must be put in double rows, on three feet ridges; the cabbages in single rows of three feet ridges.

Clay.	*Clayey loams.*
Turnips or cabbages	Turnips or cabbages
Oats	Oats
Beans and clover	Clover
Wheat	Wheat
Turnips or cabbages	Turnips or cabbages
Oats	Barley
Beans and vetches	Beans
Wheat	Wheat

Rich loams and sandy loams.		*Peat earth.*	
Turnips & potatoes	Beans	Turnips	Turnips
Barley	Barley	Barley	Barley
Clover	Peas	Clover	Clover
Wheat	Wheat	Wheat	Wheat
Wheat	*Ad.infin.*	Potatoes	Potatoes
Beans		Barley	Barley
Barley		Peas	Peas
Peas		Wheat	Wheat
Wheat			

Chalky substratum.	*Gravels.*	*Light lands.*
Turnips	Turnips	Turnips
Barley	Barley	Barley
Clover	Clover	Clover and rye-grass
Wheat	Wheat	Clover and rye-grass

Chalky substratum.	*Gravels.*	*Light lands.*
Potatoes	Potatoes	Clover and rye-grass
Barley	Barley	Peas
Peas	Peas	Wheat or rye
Wheat	Wheat	

Reaping and Storing.

In converting artificial grasses into hay, the method should be different from that used with natural ones. They should for a day or two lie in swath, after which, being carefully turned, they should remain for a day or two longer; by which easy and simple process the hay is, in good weather, sufficiently made. After remaining two days in cocks, these should be carted to the stack.

With regard to the mowing of grass, in general, for hay, the workmen should be made to cut as low as possible, by which the crop is increased, and the remainder thrives better than it would do otherwise. Many hands should be ready to assist, and five makers are not too many for every mower. The grass should be shaken out immediately after the scythe. By the evening it should be raked into rows. The next morning it should be again shaken and spread, and in the evening it should be put up into cocks. These being opened on the following morning, after a similar process, may in fine weather be safely collected into the great hay-cock at night. If successive rains come on to damage it, as it is stacked, a peck of salt should be strewed in layers on every load, which will sweeten it, and render it palatable for cattle, which would not taste it without this preparation. The stack should be covered within a week after it is finished; and a trench should be dug near it, to carry off any wet, if it be placed in a situation subject to damp. The hard hay of a poor soil is litttle subject to firing, which often occurs with respect to that made of succulent herbage. The latter, therefore, requires longer time for its making. To preserve as much of the sap of grass as possible, without incurring the danger of firing, is the grand practical problem of hay-making.

When the stems of culmiferous plants are totally divested of green, they are perfectly ripe. Some farmers recommend that wheat should be cut before this mature stage, not only to prevent any of the grain fram shaking out, but as being found to make more excellent flour from being cut before perfect ripeness, than after having attained it. The latter observation may very safely be controverted. But as it is admitted that every moment it remains standing, after complete maturity, is critical, it may often be judicious to commence the reaping of it before the period of full ripeness. Wheat has been immemorially reaped instead of being mowed, and this method ought always to be adopted, as from its high growth it becomes untractable to the scythe. When barley ground is purposely smoothed by rolling, that crop may be cut down with the scythe, which not only, from the greater rapidity of its operation, removes that grain more effectually from the danger of being shaken by winds, but brings with it a much greater proportion of the straw, for manure, than any other mode, a circumstance well deserving attention. Cutting of corn in wet weather ought ever to be avoided, if possible; and, however obvious this caution, it cannot be regarded as superfluous, as it is unfortunately very often neglected. Barley is particularly subject to injury by wet, having no protecting husk; and has a strong tendency, when cut in this state, to run to malting; it should not only be cut dry, but immediately, if possible, be bound up, to prevent its being discoloured, which will otherwise easily occur. Peas grow so irregularly as to make the sickle necessary. For removing the produce from the field, long carts, moveable upon the axle, by which the whole load is moved at once upon the ground, and lifted to the stack by persons appointed for the purpose, are preferable to other modes. Dispatch is thus obtained, when particularly required, a circumstance always worthy of regard. Instead of housing corn, stacking it is a far superior practice, as it not only, by the consequent exposure to the air, carries what is called a finer countenance, but as it is more completely preserved from vermin, than by being deposited in a barn. Every sheaf should be made to incline downward from its top to its bottom. Where they are laid horizontally, rain will be taken in both above and below. The best form for a stack is that of a cone, (the top of which should be formed with three sheaves united in a point) placed upon a cylinder. The moment a stack is finished, the covering of it should, if possible, commence; materials should therefore be previously collected. If much rain should fall before this operation is performed, it will be difficult, and perhaps impossible, to render the stack dry while it stands; and, in or-

der to prevent putrefaction, it will be often requisite to pull it down, and, after fully exposing every sheaf to the air, to re-construct it.

The method of preserving potatoes has already been suggested, and to go farther into detail on this subject would exceed our limits.

Threshing.

The usual mode of threshing is attended with the inconvenience of the straw being very often not thoroughly cleared, by which much grain is lost; and with that of affording the workmen great and perpetual incentives to depredation, which, perhaps, are rarely resisted, or at least are certainly often yielded to. A fixed threshing mill will give comparative security against these evils; and one worked by two or three horses may be purchased for from sixty to a hundred guineas, and which, in eight hours, will thresh fifteen quarters of wheat. The granary should be over this mill, and the corn may then, immediately after threshing, be drawn up into it, and deposited safe under the key of the farmer. Fresh threshed straw is better than old for feeding cattle, and is best managed for them by being cut into chaff.

Fruit trees.

The culture of trees, for the purpose of deriving a fermented liquor from their juice, employs a great proportion of the land of this, and of other countries, and is, therefore, an important branch of agricultural attention. The preparation of the juice of apples is more particularly attended to in the British empire, than that of any other fruit; and the few remarks on the general subject which our limits will permit will be confined to that fruit. The varieties of apples are entirely artificial, nature having produced only one species, which is the common crab. But different culture produces very great differences, which are preserved by artificial propagation. The seeds of the finest flavoured apples among the native species should be sown in seed beds, in an extremely rich soil; and the assistance of a frame, or even a stove, may be applied. In the first or second winter the plants should be removed to the nursery; while they remain there, the intervals between them may be occupied with garden stuff, which should not, however, crowd or overshadow them; and weeds, whenever they appear, should be extirpated. In pruning, particular attention must be given to the leader; and, where there are two, the weakest of them must be cut off. The undermost boughs should be gradually removed, and not all in one season. The height of the stem should be seven feet, or seven and a half, as the crops on a tree of this elevation are less exposed, and, indeed, the tree itself is less susceptible of injury. When they have attained five inches in girt, which they will do in seven or eight years, they may be safely planted out. Tillage is favourable, as the ground is thus stirred about them; and, where cattle are permitted to feed among them, they are apt to injure them, and, indeed, also to injure themselves after the trees begin to bear, by the fruit sticking in their throats; on which account apple grounds, not in tillage, should be eaten bare before the season of gathering. Apple trees should be carefully cleared of a redundance of wood, which intercepts the free circulation of the air. They should be kept clear also of the misletoe, which is often extremely injurious. Moss likewise should never be permitted to incumber them. The failure of crops, in particular years, is often ascribed to what is called blight; but, to adopt more intelligible language, is probably imputable to the great exhaustion of the trees by recent bearings; to prevent or mitigate which exhaustion, the best application is that of care, to bestow upon them all the natural means of healthy and vigorous vegetation. Excess of bearing, however, will inevitably impair strength. Grafting in the boughs, and when they are fully grown thinning the branches, will prevent excessive produce, and may be considered as a very probable method of procuring fruit in moderate quantities every year. As general management, with respect to orchard grounds, it is a judicious rule to plant, for such, a broken up worn out sward, keeping it under arable till the trees have attained tolerable growth, when it may with advantage be laid down to grass, and be permitted to remain in that state till the trees are finally removed. After one set of graft-stocks on the stem have become effete, a second has been successfully applied: and thus, though the effect of age will at length prove fatal, the bearing of trees has been often very long protracted. The pear tree is of much longer duration than the apple. Both should be extirpated without reluctance, when their produce no

longer compensates for the ground occupied by them.

Timber trees and coppices.

The planting of timber trees is an important aid to general cultivation, particularly in mountainous and moorish situations, where they afford shelter both for corn crops and cattle. Wherever plantations are formed in such situations, the aspect of the surrounding land is always improved, and exhibits a richer verdure. When suddenly removed, the contrary effect takes place; the efforts of human industry are then impaired; the warmth of the soil is dissipated; vegetation is pierced and chilled by the unresisted blasts which sweep along its surface; and the cattle are benumbed and stunted, for want of protection from its fury.

In a flat and rich country, plantations often operate injuriously; and lofty hedge rows, containing stately trees, check the free passage of the air and light, prevent the seasonable drying of the ground, and, in a changeful and critical climate, the corn is consequently delayed in its progress to maturity, often cannot be gathered in proper condition, and, sometimes, is completely ruined. These considerations will generally be sufficient to decide the question of planting timber trees in particular situations. Where the practice is thought judicious, with a view to the melioration of the soil, the larch, which is the quickest grower, and the most valuable of all the resinous trees, will be entitled to a preference. The most barren ground will answer all its demands for nourishment. For oak, better lands are indispensable. Beech trees under the protection of Scotch firs, previously planted for their shelter, will lay hold, eventually, even of a soil which pessesses neither clay nor loam, and thrives so rapidly as to require, in a short period, that the firs should be cut down, to afford freer air and ramification.

The use of small plantations of timber on large estates is very considerable. A vast quantity of posts, spars, and rafters, for buildings of every description on the farm, is perpetually called for in such circumstances, and will thus be fully supplied on the spot; whereas the want of it is attended with extreme expense and inconvenience. Planting should commence in October, and may be continued till April, excepting during frost. Injuries from cattle must be effectually guarded against in plantations, in their infant stage, which are as easily ruined as fields of corn. The fences, therefore, should be kept in the best possible repair.

With respect to coppices, the caution about cattle is equally necessary. When coppices have attained the age of fourteen years, they may, generally speaking, be cut down more profitably than at any other age; and the most advantageous method, after this, is to sort out the wood for appropriate purposes, whether for fuel, hoops, or hop poles; which arrangement will, in almost all cases furnishing such varieties, abundantly compensate for the time taken up in making it. In some situations, as in Surry for stakes and edders, in Gloucestershire for cord wood, in Yorkshire for railing, these articles yield a considerable advantage; and as they are sure of a market within a small distance, which, with respect to the carriage of so bulky a commodity, is a point of the first consequence, an annual fall of wood applicable to these purposes may be desirable. The ground appropriated for its growth should be divided into that number of sowings or plantations, which will equal the number of years intended for their growth before cutting. The management will thus be easy as well as profitable, and fall naturally, without agitation and embarrassment, into the regular business of the year. These plantations may be sown either in October or March. The land being in good order, it should be sown with corn or pulse, appropriate to the season and soil, after which the tree seeds should be put across the land in drills. Acorns and nuts must be dibbled, and the key berries scattered in trenches, drawn by the hoe, at four feet distance. Osiers may often be cultivated to great advantage, yielding a profit in the second, or at least in the third year; while a coppice requires 15 or 20, and an oak 100 years, to attain to its maturity.

Cattle.

A considerable part of the stock of a farmer must always consist of cattle; and the maintenance and management of these, therefore, must ever be an object of great consequence; and in proportion to the number of them which he keeps for sale, in addition to those which he employs on account of their immediate service and labour, the importance of the subject is increased to him. Whether, in the latter point of view, oxen or horses are the more advantageous, has been a long agitated question. In situations in which

there is a breed of cattle particularly adapted to work, and such situations do occur, the employment of the ox may probably be most beneficial. And when a farm is of so great extent, that a considerable number of beasts may be annually bought at a small expense, and no inconvenience may be incurred by turning out those to fatten which are ill qualified for labour, the same preference may be wisely made. Bulls are on some accounts to be preferred to oxen, being procured at a cheaper rate, and more active and persevering in labour. In other cases than those just mentioned, the question will be decided differently. The activity of the horse is extremely superior to that of oxen, and it is more applicable to different species of employment. Its hoof is less susceptible of injury; and, with respect to well managed farms, in which dispatch is more required than absolute strength in the operation of ploughing, the quickness with which the horse completes the business, in comparison with the ox, will, it may be presumed, at length generally diffuse that preference of the one to the other, which is obviously increasing every day. Yorkshire is the most distinguished part of England for the breed of horses, particularly for the saddle, and the black cart horse of the middle counties has been long celebrated. In the north of England, a very valuable breed from Lanarkshire in Scotland has lately been encouraged, of extreme activity, though not fit for particularly heavy draught, passing over a vast surface of land in a short time, and highly useful, therefore, not only in ploughing, but in the general work of a farm. The Norfolk management of horses, as instruments of agriculture, is considered by many as the cheapest that can be practised. In the winter months their sole rack meat is barley straw. In the most busy season a bushel of corn is thought an ample allowance, and the chaff of oats, which is far preferable to that of barley, is universally mixed with it. They are in summer kept out all night, and their feed is generally clover only. A great saving in the maintenance of horses has been obtained by the substitution of roots for grain. Turnips and potatoes have been given them in a raw state, in which case, if hard labour is required of them, some corn in addition may be expedient. If these roots are boiled, however, the corn may without injury be dispensed with. Carrots are better for horses than potatoes, and both are thought extremely serviceable in preventing various disorders to which they are subject, particularly the grease. Carrots are deemed an effectual cure for what is denominated thick wind in horses; and to broken winded ones, are of admirable use in palliating the complaint.

The practice of soiling horses, instead of turning them to grass in summer, is by many experienced men thought by far the superior method. The produce thus managed goes three times as far as if consumed in the field. The injury done by feeding pastures with horses instead of sheep or oxen, an injury very material and obvious, is avoided; and the dunghill, which, in all situations at a distance from towns and cities, is an invaluable object, especially if plentiful littering be allowed, is sufficiently benefited to compensate for this expense of their keeping.

Black cattle, intended for feeding, should be chosen for their being short-legged, which quality is almost uniformly connected with a general good make. Straightness of back is another important recommendation, and the more perfectly straight they are, while at the same time they are very broad and flat on the loins, the more readily experienced judges will decide on their worth. Smallness of dewlap, and the barrel form of carcase, both in the fore and hind quarters, are also justly insisted upon as points of excellence. A curled hide is indicative of a thriving beast, and worthy of observation in the choice of these animals. A still more favourable symptom is a softness or sleekness of skin. Indeed, the nice touch of the hand is requisite in the judge of cattle, perhaps nearly as much as the keen observation of the eye. Oxen that have been worked are more valuable to graziers than others, as not only fattening with greater rapidity, but furnishing more excellent beef. After working till the age of fourteen years, which is within two of the usual extent of their natural life, they have often supplied most tender and admirable meat.

It is a consideration of great importance to the grazier, that he should always secure such a stock of winter food for his cattle as will maintain them during that season, reserving them for the spring market, which is always superior to that of autumn. From the beginning of March to that of June, the change of prices will be completely in his favour; and in order to avail himself of this, he must so arrange his affairs, as to pro-

cure an adequate stock of winter maintenance. Whatever food is used for this purpose besides hay, the latter is always to be implied, and from seven to fourteen pounds a day should always be allowed to each beast. For hastening the process of fattening an ox, linseed cake has been found superior to every other article. Its price, however, of late years has been more than proportional to this advantage. Carrots complete their fattening with a nearly equal degree of celerity; and an ox will eat a sixth part of his weight of this root every day; at which rate an ox of sixty stone may be supported by the produce of an acre of these roots for upwards of five months. Two beasts, of the weight just mentioned, if half fat when put to carrots, might become completely so by consuming the produce of an acre. Cabbages are but little inferior for the purpose to carrots and oil cake. An ox will eat of them nearly one fifth of his weight. Turnips are the most common description of winter food, but possess not the same fattening quality with the substances enumerated; and, being a crop susceptible of various injuries, are much less to be relied on than many others. Of these the consumption of twenty-five ton is deemed necessary to fatten a beast of about sixty stone.

In consequence of eating succulent plants, and particularly clover, beasts are apt to swell greatly and very dangerously, in which case driving them about with great rapidity is often practised with success, though a still more effectual method is to stab them between the ribs and hip bone, to the depth of about four inches. A flexible tube has also been frequently passed through the mouth into the gullet, by which the air, which causes this disease, is easily discharged.

The practice of stall-feeding, or keeping the cattle in the house at every season of the year, and feeding them, when practicable, with green food, where there is abundant litter, is considered by excellent judges as the best method of turning to account the produce of the soil. Double the usual quantity of manure also is thus produced; and the annoyance of the cattle in any great degree by flies and insects is effectually precluded. This plan has been long and extensively practised in Germany, and is making its way in England, under the encouragement of many judicious agriculturists. Not only may grass be thus employed for food more profitably than in any other way, but boiled roots may be used with extreme advantage, with a view either to maintain or to fatten cattle; and, ridiculous as the idea of this management for a vast number of cattle and horses might at first appear, it is found capable of being performed, with the aid of a steam engine, by one superannuated attendant. The roots may be permitted to retain their original form, or may be mashed and converted into thick soup, as is deemed most eligible.

Cleanness and temperate warmth in the process of fattening beasts for human food are of the utmost importance; and it has been philosophically remarked, that analogy will lead us to conclude, what observation justifies from fact, that whatever tends to form in beasts a state of feeling, unirritated by fear, vexation, or pain, must tend to shorten the period necessary for advancing them to their maturity of size and excellence.

Sheep.

Towards the end of August, the annual purchase of wether lambs, for an estate on which regular flocks are not kept, generally takes place. These are justly preferred for stock to all others. The new Leicester have the advantage in competition with all the long-woolled breeds, and the South Down with all those of short or middling wools. For severe and mountainous moors, the black-faced and coarse-wooled Scotch sheep are by far to be preferred, being able to sustain the most rigorous weather, and to live on the most scanty food. Instead of putting sheep, after the above-mentioned purchases, to the highest feed, and pushing them to perfect fattening, the better way is to keep them tolerably well till March, and to begin then to fatten them, by which method they will be fit for sale at a season of more advanced price; and upon this plan the purchase money is, with good management, generally doubled, and the fleece found an additional clear advantage. Whatever be the nature of the stock, towards the middle of May they should be turned into their summer-grass, and, in an inclosed farm, the division of the fields into different parcels intended to be fed is an object of great importance. It is justly thought, that in large parcels they do not thrive equally well as in small ones, and the waste of food is considerably greater. It will be found, that in flocks of from ten to twenty the same farm will keep considerably more than in one flock. The number should be appropri-

ated to each field, according to what it is enabled to carry, and suffered to remain, without any other change than what depends upon the state of individuals from accident or season. They will thus inevitably flourish. By adhering to the practice of folding, which, however, in certain cases may be necessary, much loss is often sustained; much food is spoiled; and injury arises from numbers being so closely crowded together: and although the practice may be highly beneficial, as preparative for corn, this advantage is often too dearly paid for. Another point of very considerable consequence with respect to sheep is the practice of close feeding. Even in pasturage shorn completely to the ground, the herbage is found rapidly to spring up; and when drought is observed nearly to destroy the produce of fields treated in a different manner, by being permitted to run to bent, such as are managed in this close way are in comparison at least highly productive. In all plants cultivated for pasture, the moment the seed stem runs, the grand effort of the system is directed to the formation of the seed; and the way to produce the greatest abundance of leaves, therefore, is to prevent the rising of these stems, which, by close feeding, is of course effectually accomplished.

In the whole range of husbandry, perhaps, the most perplexing point of management is the providing for flocks of sheep in the months of March and April. Turnips and hay are generally depended upon; but being frequently inadequate, rye is sometimes sown on purpose, and crops of wheat are also sometimes eaten down by them. All, however, is too frequently found insufficient, and they are permitted to run over the clover and pastures of the farm, committing great waste and damage. To prevent these evils, burnet should be cultivated by the farmer. It is a most hardy plant, and preserves its green leaves through the winter, and under deep snows vegetates with singular luxuriance. This will be an admirable feed for sheep in April, when turnips ought no longer to remain upon the ground. But kept grass on dry meadow and pasture, or what is called rouen, is preferable to every other dependance, and though consisting as it were of hay and grass in the same mouthful, being the autumnal growth at top, sheltering the more recent vegetation beneath, the sheep eat both together without the slightest hesitation, and are found to thrive upon it extremely. Ten ewes, with their lambs, may be supported throughout April on one acre of this rouen, and no cheaper mode of keeping a full stock in April can possibly be adopted.

In June the washing of the sheep should generally take place previously to the shearing. The washing may be best performed by a stream of water; and those who are engaged in it, instead of standing in the water, in which their uncomfortable situation leads them to hurry negligently over the business, should, by means of a cask or tub, be freed from such unpleasant and dangerous exposure. The shearing, which speedily follows this operation, should be as close as possible, and the circular is by far preferable to the longitudinal method with a view to this object.

Sheep that are kept in inclosures, and particularly in a woodland country, should be examined twice every day, to guard against injury to them from the fly, which, in twenty-four hours after having struck, sometimes produces incurable disease. The most efficacious treatment on this subject is, after parting the wool wherever the maggots are found, and picking them out with a knife, to scrape a small quantity of white lead among the wool, so that it may be carried evenly down to the wound. Regular and minute inspection will prevent such a circumstance as a broken coat in any of these animals, from a cause so dangerous and fatal, where they are neglected.

When ewes are about to lamb, their keep should be of the most nourishing kind, consisting of plenty of turnips or cabbage. Till this period they may do without them. But all cattle that have young require as good keeping as those which are fatting. The turnips or cabbages should be drawn for them, and given them on dry ground. A standing rack of hay should be left for them on the field, which will be of great advantage to them.

Swine.

The quick multiplication and growth of swine render them a species of stock highly profitable, and if reared systematically, and upon a large scale, none will be found to answer the purpose of the farmer better. Though supposed to be filthier than any other animals, they enjoy a clean and comfortable place for laying down in, and their thriving and feeding are at least as much improved by cleanly management as those of any other stock. Their styes should therefore be constructed

sloping, to carry off all moisture. The different sorts of swine should be kept separate in them, and many should never be put together, and particularly if they be of different size. Too much attention cannot easily be paid to the rearing of these animals. The large Chinese breed is generally and justly preferred. When swine are reared on a comprehensive plan, crops must be sown purposely for their support, and the dairy cannot be considered as that resource which it is naturally regarded in small farms. From October till May, potatoes, carrots, cabbages, and the Swedish turnip, which is a most useful vegetable for this particular purpose, must be provided for the swine, and stores from October till the end of May, when they may be received into lucerne, chicory, or clover, on which they will be maintained till the clearing of the stubble; and thus, with the offal of the barn and the corn fields, and the plants and roots just mentioned, the whole year will be amply provided for. In summer, meal must be mixed with water for the sows as they pig, and in winter boiled roots, peas, and oats, should be given to the young ones. Dairy wash is a capital addition to this mixture. The sows should be permitted to pig but twice a year, in April and August. When great with pig, they must be carefully secluded from the boars, and shut up about a fortnight beforehand in the stye; and while pigging, it is of extreme consequence that no one approaches them, or is even seen looking at them, as in this case they will often devour their farrow. After a week from this period, they should for a few hours in the day have the freedom of the yard, which will be a great relief from total confinement. Winter pigs, if not kept with great attention, are found less profitable than others. Milk and whey may so usefully be applied to them, that perhaps no other mode of their application is equally advantageous; and the best process for weaning them is by giving these articles to them mixed up with peas-soup, though the latter alone will answer well. When three or four months old, nothing is better for them than clover: turnips alone will not be proper, but corn should be added to them. Carrots and potatoes will keep them well till their full growth. Malt grains, if easily and cheaply to be procured, are highly to be recommended.

With a view to fattening hogs, the corn employed should be ground into meal, and in the proportion of five bushels to 100 gallons of water should be mixed in large cisterns: the mixture should for three weeks be well stirred every day, and at the end of that period will have fermented and become acid, before which it should not be given. A succession of vessels should be filled with this fermented food, that some may be always ready; and, before it is applied, it should be always stirred. Peas-soup is perhaps equally wholesome food with the above, and especially if made with warm milk. The preparation, however, is more expensive. Fatting hogs should be constantly well littered, and be kept perfectly clean.

Poultry.

With respect to poultry, constituting as they generally do part of the stock, however small, upon farms, a few observations on them may not be thought superfluous. If kept merely for domestic supply, particular attention is needless. When reared with a view to profit, however, and on a somewhat large scale, they will repay, as they indeed require, considerable attention. A house should be erected for them, containing divisions appropriately for roosting, sitting, fatting, and food. The building should be constructed near the farm-yard, having clear water contiguous to it. Warmth and smoke are great cherishers of poultry. All, of every species, must have access to gravel and grass. Their cheapest food consists of boiled potatoes, on which it appears that they can be supported and fattened without the aid of any corn. Where numbers of them are kept upon a farm, if permitted to go at large, they will often do considerable injury both in the fields and barnyard; besides which they will be extremely exposed to the attacks of vermin, and will lose a considerable number of their eggs. A full-grown hen continues in her prime for three years, and may be supposed in that time to lay 200 eggs, which number, however, by warmth and nourishment, might be greatly exceeded.

The quality and size of the Norfolk turkeys are superior to those of any other part of the kingdom. They are fed almost entirely with buck-wheat, which, perhaps, may account for their excellence, and are bred by almost every little farmer in the county. When young, they demand perpetual attention, and must be fed with alum curds and chopped onions, and the expense attending their management and food can be compensated only where broods are tolerably successful, and the prices high.

The Dairy.

In the conduct of a dairy, which, in all but the most productive corn countries, is an object of particular consequence to the farmer, it is obviously of the first importance to select cows of the best sort, and in judging of the value of this animal, the best method of deciding it is by the quantity of cream produced in a given time, rather than of milk. The richest milk known is produced by cows of the Alderney breed; but, in all countries, cows yielding a very superior quantity of milk to the generality are to be found, and should be sought for by those persons to whom their produce is a particular object of attention; and the breed of such should be particularly cultivated. Rough waste lands, when the soil is wet, will do better for cows than sheep, and should be always appropriated to them, not indeed because they are the best for cows, but because no stock will so well pay upon them.

The grand object of keeping cows being the production of abundance and excellence of milk, they must, for this purpose, be supplied with food of the same description. About a month before they calve they should be taken from the straw-yard, and have green food given them twice a day, with the roots, whatever they may happen to be, which have been raised for their winter food. Having calved, they should be kept perfectly separate from the lean stock, whether in the house or in another yard, and their food should be continued as before. Winter feeding cows with hay, even though none be given them before they calve, breaks in greatly upon the profits of the dairy Cabbages will maintain them in the cheapest manner, and not give any unpleasant flavour to the milk and butter. The heart alone of the cabbage, however, should be given to them, and the refuse leaves be left to be picked up by the lean cattle. In the month of May they should be kept in particular good feed, for which purpose they should be turned into the fields of clover, which had been early eaten off by sheep. Lucerne is, however, perhaps preferable to clover, as it is equally nourishing, and gives no ill flavour. When mown, and given in racks or cribs, it will go farther than in any other way, and yield an increased quantity of the most valuable manure, a circumstance which has been often insisted upon, and cannot be too frequently suggested. The feeding place should be kept extremely well littered. The profit of cows, in these circumstances, will be greater than turning them into luxuriant fields of these artificial grasses, although the quantity of their produce might, by the latter method, probably be increased; but by trampling upon and spoiling considerably more than they would eat, the little superior milk in richness or quantity, which might be produced, would be purchased at a most heavy expense, and one acre so managed would be requisite for every cow, while, by soiling, it would be amply sufficient for three. The clear profit in the comparison of any two modes of management is the grand point of the farmer's consideration, and whatever the farmer finds most profitable, will eventually, it must be remembered, most benefit the public. Whatever green meat be thus used in soiling should be fresh mown every two days, the quantity being, as nearly as may be, adapted to the number so fed, not only of cows, but of other stock. Lucerne, if well managed, will bear four mowings for this purpose.

Cows should be milked three times a day, if fully fed, throughout the summer; and great caution should be exercised by the persons employed to draw the milk from them completely, not only to increase the quantity of produce, but to preserve its quality. Any portion which may be left in the udder seems gradually to be absorbed into the system, and no more is formed than enough to supply the loss of what is taken away; and by the continuance of the same mode, a yet farther diminution of the secretion takes place, until at length scarcely any is produced. This mode of milking is always practised, when it is intended that a cow should be rendered dry.

The apartments appropriated to dairy purposes should, if possible, possess a moderate temperature throughout the year, and should be kept perfectly clean and dry. The temperature of about fifty five degrees is most favourable for the separation of the cream from the milk. The utensils of the dairy are best made of wood; lead and copper are soluble in acid, and highly pernicious; and though iron is not injurious, the taste of it might render the produce of the dairy unpalatable.

Objects of attention, with a view to the settlement and success of a young Agriculturist.

It is an object of extreme importance and difficulty to awaken due attention,

without exciting useless anxiety. In selecting a situation in which to exercise the occupation of a farmer, various circumstances are minutely and deliberately to be regarded, and great consideration is required to form an accurate comparison of advantages and disadvantages. After these have been fully ascertained, a balance is to be drawn, and a decision to be made. More attention than time is requisite for this purpose, and hesitating, broken application will often occupy a longer period in arriving at an injudicious determination, than, with persevering and dispassionate examination, is necessary to obtain a correct one. Headlong temerity, which diminishes, or even annihilates to the mind, substantial evils, and minute, apprehensive prudence, by which every ant-hill of difficulty is made to swell into a mountain, are both to be carefully avoided; and a firm confidence in human exertion should unite, on this critical occasion, with keen and comprehensive observation. The soil is an object of particular consideration, in reference to a vast variety of circumstances; as to its stiffness and moisture; levelness or slope; its exposure or its stoniness; the manuring, draining, and fencing that may be required; the state of the roads; the accessibility of markets; the prices of manufactures, of produce, and labour; the custom of tythes; the amount of poor-rates; the compactness of the land, and the covenants concerning crops; are only a few of the points which demand, in such circumstances, to be duly ascertained and estimated. To fix on good land is a prudential general direction. For such it is not easy, with ordinary discretion, to pay too much, while for poor soils a small rent very frequently exceeds their worth.

The most advantageous of all soils are, the mellow, putrid, crumbling, sandy loams; those which will admit tillage, soon after rain, and, though finely harrowed, will not harden, as if baked, in consequence of the hottest sunshine, after violent rains. The stiff loam, which is very nearly approaching to proper brick earth, is, without plenty of manure, an unfavourable soil. On walking over it, it is found extremely adhesive in wet weather, and it requires a long time to dry. It may be considered as forming a medium between the clods of clay and the crumblings of loam. In stubble, a small green moss is frequently seen to cover it. By farmers, poverty and hunger are metaphorically and most expressively applied to this land, which has a great number of varieties. It requires a large quantity of manure, and is wonderfully improved by hollow ditching. The expense of these operations must never be forgotten, in connection with an estimate of their result.

Warm, dry, gravelly loams are, in winter, easily distinguishable. Unless in a particularly wet winter, they may be ploughed during almost any part of it, and will break up in a state of crumbling, running mould. A very bad soil is constantly formed by wet, cold gravel, which, in winter, is always indicated by its wetness, and in spring is known by the binding effects produced upon it by short and violent showers. It can be fertilized only by very extraordinary quantities of manure: and drains, fully and neatly completed in it, will considerably improve it. Some gravels are of so particularly sharp and burning a nature, that, unless the summer be particularly wet, they will produce absolutely nothing. At any season this soil is obviously distinguishable. With respect to sands, the rich, red sand possesses always a dry soundness, and a temperate moisture, and will, in the driest summer, secure a crop. Its excellence and profitableness can scarcely be exceeded. Another admirable soil is formed of the light, sandy loam. It may be ploughed during the whole winter. The degree of its adhesion is precisely that of its perfection. It may be usefully observed, that when stiff land is dry and crumbling, it is a sure indication of its goodness, as the adhesive quality of a sandy soil is, with respect to that species of land, an equally decisive symptom in its favour. That which falls flat in powder is a mere barren sand. The chalk marle runs exceedingly to mortar from violent showers, after being pulverized, and is a cold and unprofitable soil. Clay land of great tenacity is usually let for more than it is worth; and though it will yield abundance of wheat, is attended, in its management and preparation, with so great expence, that its profit is often trifling, and fortunes are far more frequently made by lands of a directly oposte description, consisting of light and dry sand. The common fault of stiff clays is wetness. Where fields are level, and, even though the furrows are well ploughed, the water stands in the land, the extreme tenacity of the soil is obvious. It is also broken up by the plough only by a very powerful draught of cattle, and in pieces of vast size and extreme hardness. In winter, soils approaching to

this character are most to be distinguished. They will yield large crops of beans and wheat, but the sight of these should always be blended with the consideration of the immense expense at which they are necessarily raised. There are many variations of peat, bog, and fen, and all may be found exceedingly profitable; and if marl or lime be in the neighbourhood, that circumstance is a most important inducement to undertake the management of them.

With regard to grass lands, they are to be best examined at several seasons, in order to ascertain their character. If they be too wet, this is shewn by walking over them in winter, and by rushes, flags, and moisture, which, in a greater or less degree, are always observable upon them. The grass is generally blue at the points, and always coarse. Draining may correct stiff loams, but the stiff tenacious clay is scarcely susceptible of cure. Grass, on gravelley soils, will inevitably burn in hot summers, but will extremely abound on loams in wet ones. On the banks of brooks and rivers, meadow of almost any soil may be considered good, but the circumstance of their liability to summer inundations ought never to be forgotten.

The herbage on many fields is sometimes composed of weeds and the coarsest and worst of grasses, which are at all times discernible, and indeed glaring. Under a prohibition of arable, which is sometimes and not unfrequently the case, fields of this description are worth little or nothing. A river, well restrained within its banks, running through a farm, is a circumstance decidedly favourable. The grass lands may thus be presumed to have water for the accommodation of cattle.

The quantity as well as the nature of the soil, is likewise to be considered, and no larger quantity should be occupied than can conveniently be stocked. The bad management, and the perpetual embarrassment occurring in the contrary situation, are often ruinous to the health and to the fortunes of those who are involved in it.

The disjoined situation of the various fields of a farm is a circumstance attended with great vexation and expense. Compactness of estates will always render them far more valuable; and opportunities of producing this compactness, by purchasing at a fair valuation, will never be neglected by vigilant and wealthy landlords.

To estimate the rent correctly, it has been judiciously recommended to connect it with tithes and poor rates. Whatever sum be intended to be invested in the farm, its interest may be fairly calculated at not less than ten per cent. A valuation of the expense and the produce should, for the next step, be carefully made: and, after the former is deducted from the latter, what remains will be the sum which can be allowed for the demand of rent, in the three different forms above mentioned. If the amount of tithes and rates be deducted from this, what remains will be the sum which the occupier can afford to pay the landlord.

The nature of the covenants required, which are sometimes only absurd, and therefore admissible without difficulty, but sometimes equally absurd and mischevious, ought ever to be considered in connection not only with general but local and peculiar circumstances. The unreasonableness of the conditions proposed will sometimes be a valid objection to that occupancy, which rent and situation, and all other circumstances, might render highly eligible, and compensation in diminished rent will be necessary to indemnify for tying down the farmer from modes of cultivation uninjurious to the land, and inexpressibly the most beneficial to the occupier.

From three to five pounds per acre was, about forty years since, considered adequate to the stocking of any farm, partly grass and partly tillage, of the average fertility. The increase of rents and of rates, the higher composition for tithes, the advance upon all implements of husbandry, and upon every species of sheep and cattle, may be justly considered as having raised the sum necessary for the above purpose to seven or eight pounds. To form calculations upon this subject as accurately as possible, and ascertain that the requisite capital is possessed, for the due management of the land to be occupied, cannot be too emphatically insisted upon. The profit attending an increased expense in stocking will, in some cases, more than double the ratio of profit before that increase; and if the farmer be incapable of availing himself of striking opportunities for improvement, by the purchase of litter or of manure, and indeed by a variety of circumstances which may easily be suggested, for want of capital, his situation must be highly disadvantageous.

The choice of servants is a point requiring extreme attention. Where the assistance of a bailiff is required, as in all farms of very considerable extent, he

should be of a somewhat superior description to those whom he must be authorized to command. The making of contracts, and receiving money, which afford agents great temptation to dishonesty and to excess, should, whenever practicable, be performed by the principal. Of the inferior servants, the ploughmen are of most consequence, and skill and docility are their grand reccommendations. It is desirable, that all the servants should be under the master's eye. His constant superintendance will have great effect in promoting their sobriety and regularity, and not only will their permanent happiness be improved by this plan, a circumstance to a man of humanity of no light consideration, but their greater tractability and obedience will render the practice of this domesticating method, in a selfish point of view, more useful to him, than that, according to which, on many extended estates, the men and boys are all committed to the boarding and management of the bailiff. It may be considered as in general preferable to keep many servants and few day-labourers in the present times. The certainty of commanding hands at all seasons is an object of prime importance, and the difficulty of procuring additional ones, when they are most wanted, is often upon the other plan insuperable.

It will be always eligible and expedient to pursue a *system* of management, comprehending every department of business and expenses. The carelessness of profusion and the sordidness of penury, must both be avoided with equal caution. A fixed sum, formed upon calculations, resulting from actual experiment, should be allotted for the expenses of the house, for personal expenses, for family dress, and other necessary demands, to be by no means exceeded, and as casual demands will always occur, a reserve should always be provided for contingencies. This methodical arrangement cannot be too strongly enforced on the young practitioner, who, without it, is in danger of inextricable confusion and ruin. If the investment on a farm be eight thousand pounds, after clearing all expenses arising from regular or contingent demands, and maintaining the establishment in liberal but accurate economy, if a hundred a year be not annually added to the occupier's capital, the concern must decidedly be a bad one. The addition of one hundred and fifty is very far from unreasonable. Whatever it be, in general, it cannot be better employed than in prosecuting ascertained modes of improvement upon the farm, if it be the property of the occupier, or if he is in possession of a long lease.

Attendance at markets and fairs is an indispensable part of the farmer's occupation, but in a young man is attended with various temptations such as sanguine and social temperaments find it difficult to resist. Caution therefore to such is perpetually requisite. Moreover, the society of persons in a superior style or rank in life, which, in consequence of establishments for agricultural improvement is easily accessible to the young man of vivacity and spirit, cannot be cherished without danger. His mind is thus alienated from his regular, and comparatively very laborious, and as it may weakly be deemed, humble occupation. and fastidiousness, discontent, and neglect, will usurp the place of tranquil and active industry.

Such intercourses are completely beset with temptation, and have often induced imitation and profusion, neglected business, and eventual, and indeed speedy destruction.

Impediments to agricultural improvements.

The want of wise laws on this subject has ever been a serious obstacle. The produce of land, and the various manures which are necessary for fertilising it, can be easily and cheaply conveyed only along good roads and navigable canals, and in proportion as a country is destitute of these, it is deficient in a grand source of national and agricultural prosperity. Arrangements on these topics cannot easily occupy too much of the attention, or at least meet with too much of the encouragement, of the wise statesman. And as indefinite advantages might be derived from positive regulation on these and other details, in behalf of husbandry, much might also be done in many countries by the removal as well as by the enaction of laws. Where the husbandman is precluded from the best markets, the art of cultivation cannot possibly be pushed up to that point of maturity which it would otherwise acquire; the attainable perfection of this, as well as every other art, depending on the encouragement it finds or, in no less accurate, though perhaps more harsh and grating language, on the profit it produces. The most effectual mode of procuring the growth of any article in abundance is to insure it a reasonable price, and a rapid sale. Freedom of exportation from one country to another

affords considerable facility for these, and promotes, therefore, the object which the blindness of former times supposed to be counteracted by it. Abundance is ascertained to be secured by the very means which the contracted policy of departed legislators imagined necessarily to defeat it. Such narrow views are, however, in general exploded. And though in countries, where, as in Great Britain, the subsistence of the population is inadequately provided for by the natural produce, even in the best of seasons, there is less reason on this subject for complaint, than would operate in other circumstances, it is still an invariable and invaluable maxim, that no lands can be cultivated to their highest point of perfectibility, where restraints are permitted to operate on the disposal of their produce.

The operation of the tythe system must be considered as one of the most serious impediments on the subject under consideration. This odious and oppressive mode of providing for a class of persons, whose peculiar duty it is to polish the uncouthness of savage man, to inculcate on the world the principles of conciliation and kindness, furnishes a most singular dissonancy between the means and the end of those who instituted it; and its unmitigated continuance to the present day is a reflection on the sagacity, the energy, or the patriotism of the British legislature. Regulations, by which those who have no share whatever in the expense of improvement should participate in its advantages, are not mere topics of theoretical absurdity, but attended with serious detriment in their operation throughout this country, in a moral, a religious, and what is most of all to the present purpose, an agricultural point of view. With all the respect due to the representatives of a mighty empire, and with the most decided detachment from all points of vague and general innovation, this important subject cannot be too frequently presented to parliamentary attention. Human wisdom and human virtue will, it is hoped, be at length found equal to the correction of an absurdity at once so glaring and so prejudicial.

The want of due estimation of the occupation of husbandry, is in many countries a grand impediment to its progress. Where the cultivation of the soil is regarded with contempt, or as beneath the attention of men of rank and education, it will be entrusted to the management of persons of narrow capitals, and still narrower minds. Such prejudices operate in various places. They till lately existed to a great extent in France, and are yet deplorably prevalent in Spain. In England, fortunately, they are every day rapidly dissipating. Agriculture is ascertained to be the road to wealth and respectability; and men of high connections and distinguished fortunes think themselves honoured, instead of being degraded, by a regular and assiduous application to it, and by establishing their sons in situations, in which they may look to it as the means of maintaining families, accumulating property, and doing service and honour to their country.

Agriculture is very injuriously checked by the occupier of land not possessing in it a requisite interest. Even in this country, large portions of land are held by communities of persons, the individuals of which have no right to any particular spot of it, and are not only thus precluded from personal and active cultivation, but, by the scanty right and profit which they possess in the general property, possess no sufficient motive to enforce correct management and improving cultivation on those persons by whom it is actually occupied. Family entails and short leases are likewise eminently hostile to full cultivation, upon the obvious principle, that men will ever apply their capital and exertions only in proportion to their expectation of advantage. Even when leases are granted of a reasonable number of years, restrictive clauses are too frequently introduced, by which the progress of improvement is arrested, and a mode of cultivation insisted upon contrary to the views and the interest of the occupier, and not by any means more beneficial to the owner, than what was designed to be adopted, often inexpressibly less so. Prejudice and caprice in the proprietor are often substituted for the judgment of experience; and a routine of practice compelled upon the cultivator, in consequence of which, curious research and attentive experiment are rendered nearly superfluous. Superior knowledge, which would in these circumstances be almost useless, ceases to be sought for, and stupid acquiescence is substituted for lively observation. It is however of importance, that, towards the close of a term, the series of cropping should be regulated by covenant, as the inducement to exhaust land, to the extreme injury of the owner and the public, would otherwise be seldom resisted. Beyond this object, it is unwise to enforce restriction or to yield to it, and whatever discoveries are made by the personal ex-

perience of the farmer himself, or are derived from the experience and practice of others, it is desirable that he should ever be free to avail himself of them. The liberal ideas on this subject, which have been suggested by the best writers, and adopted by enlightened landlords, will unquestionably, in time, and it is hoped rapidly, prevail, to the almost total exclusion of those narrow and pernicious notions which have hitherto existed.

It is desirable that the farmer should occupy a sufficient tract of land to engage his time, not irregularly and occasionally, but fully and completely, by which means his attention is not distracted from this important employment to others which would interfere with it, and necessarily prevent its correct and profitable management; and those idle habits, connected with public injury and individual ruin, are effectually precluded. A large farm, therefore, generally speaking, is far preferable to a small one, in this as in every other point of view. Some persons, not having employment for themselves in the superintendance of the different departments of husbandry on their land, have recourse to personal exertion, and substitute themselves for labourers, a plan which is extremely unwise. The true art of farming consists, not in driving the plough, or engaging in other menial offices, but in allotting and superintending labour, in recording its results, and contriving how and where to dispose of it to the most perfect advantage. To read, and think, and attend the public markets, and regulate accounts, and observe what others in the same occupation in the neighbourhood, or even at some distance, are engaged in, is of far more importance to the advance of agriculture, and the profit of the individual cultivator, than for him to engage in those manual operations, which, in consequence of more practice, are generally performed with more rapidity and success by common labourers. On urgency of business, or as an example to his men, and to give their employment that estimation and dignity, the idea of which will ever render them at once more happy and more dexterous in it, it will be extremely proper for him to engage occasionally even in these, and his education ought always to have been such, as to enable him to practise them with some degree of skill and neatness, by which he will of course be better enabled to judge when they are well performed by others. But let him consider himself as the manager of a grand manufacturing establishment, requiring peculiar and incessant vigilance; of a concern, in which occurring contingencies, often require a change of plan, in which the exercise of judgment is perpetually demanded; and through the want of a sagacious and presiding mind, the manual labour of many, convertible to extreme advantage, may easily become productive only of mischief, or may have substituted for it negligence, indolence and dishonesty. This situation of continued superintendance is the proper situation of the farmer; and in proportion as he does not occupy land sufficient to require it, he engages in the profession with incorrect views, and misemploys his time.

But whatever this quantity of land may be thought to be, differing certainly in relation to different individuals, the importance of adequately stocking and preparing what is actually occupied is extreme. To unite the portion of land necessary to occupy the time of the experienced farmer, with the complete means of its fertility and improvement, affords the most suspicious foundation for the hope of success. For frequent and fine tillage, and abundant manure, which are essential to the perfection of husbandry, considerable expense is demanded. The most skilful servants, the most correct implements, the most robust cattle, are necessary to produce that improved tilth, which is the most productive cultivation, and will amply repay the extraordinary expense incurred in obtaining them. The procuring of manure in abundance, to repair the exhaustion of the soil, and not only keep it in heart, but carry it towards that point of fertility, beyond which additional expense will be incapable of returning proportional produce, is also a matter often of extreme difficulty and cost. The importance indeed of adequate means is so obvious, that it might perhaps by some be scarcely thought excusable to insist upon the subject. But the frequent and ruinous neglect of this consideration will, by others, be regarded as an ample justification of enforcing most emphatically and repeatedly the idea, that the perfection of agriculture can never be attained without an unembarrassed and abundant capital. With an inadequate capital, on a large extent of land, the same consequences will take place, which formed the most striking and decided objection to those little farms, which, however strange it may now appear, were formerly thought the grand foundation for national plenty and perfect husbandry. The produce

must be carried to market, not at the season most advantageous, but almost immediately after the harvest, in order to enable the farmer to extricate himself from immediate embarrassment, and prepare the soil, inadequately as it must be done in these circumstances, for fresh cultivation. Commercial monopoly is considerably favoured by this compulsion upon the farmer for selling at whatever price is offered, and artificial scarcity, though now not much to be dreaded in this country, is more likely to originate from this circumstance than any other. Those grand operations of spreading marl over large districts, at the rate of one hundred and fifty tons per acre, of conveying immense quantities of dung from towns at the distance of twenty miles, of floating meadows at the cost of five pounds per acre, of draining lands at the expense of three, of paying persons to reside in distant shires, or even countries, to acquire superior practical information, or of improving the breeds of sheep and cattle, by giving for the use of a single animal, for a season, a price at which our ancestors would have been absolutely astonished and confounded; practices, which, happily, have been far from uncommon in the British empire, and are daily adding, perhaps more than any other cause, to its stability and prosperity, have depended entirely upon abundant capital. Such processes for improvement might as easily be expected in the management of those small farms, formerly so highly extolled, and now so justly in theory exploded, as in the conduct of large tracts occupied only by men of embarrassed means. The supply of present exigencies preclude those comprehensive and remote views, on which the success of the art most materially depends, and unthrifty savings and corroding cares are substituted for the liberal expenses and delighted hopes, which must attend the skilful application of comparative opulence.

Finally, as the art of husbandry is particularly intricate and comprehensive, and those engaged in it are generally persons of slight education, secluded in a great degree from mutual intercourse and comparative observation, ignorance may very justly be considered as an obstacle to its improvement, perhaps the most operative of all. Instead of being collected, like artists in cities, and possessing opportunities for animating curiosity, and benefiting by communication, they are scattered over the surface of the country, and have cultivated generally the same lands, and the same prejudices, as their ancestors, for a series of generations. Unless there be among the number of those engaged in this art, a certain proportion of persons of intelligent and educated minds, capable of turning the experience of themselves and others to advantage, and deriving assistance to agriculture, from the discoveries of other sciences or arts, it would be vain in any country to expect its rapid approach towards that perfect standard, to which every human effort should be referred. That the proportion of such characters has considerably increased of late years in this country, is an observation no less true than pleasing; and in the class of persons engaged in agricultural pursuits, it may be safely affirmed there exists much less tenacity of prejudice, a far greater disposition to research, and openness to conviction, than were to be found in any former age. Even though, in some instances, old and absurd routines of practice may have been maintained with more constancy, through the hasty projects and absurd expenses of some innovaters, whose failure has checked the spirit of improvement, and unjustly involved in one common ridicule all deviations from ancient custom; these effects, however much to be regretted, are only partial, and information is still making its way into the most remote recesses, and the most stubborn minds. With a view to lessen the darkness and intricacy yet connected with the subject, to prevent random speculations and ruinous projects, with their ill consequences of every kind, it may be observed, that it is of the very first importance, that persons engaged, particularly on a large scale, in the profession of agriculture, should keep correct accounts of all their transactions, and of all their profits and losses. The advantages of clear accounts are obvious in every other occupation of life. Persons who are engaged in speculations of merchandize, to any extent, and who are known not to attend to this department, are always supposed to be in dangerous circumstances. Agriculture seems by many to be considered an exception to all other species of business; that it may be engaged in without preliminary study, and is capable of being properly conducted, even to a large extent, without any regular accounts, necessary as these are admitted to be in other situations. With respect to experimental agriculture, no correct conclusions are to be drawn but from correct and minute details. Suppositions drawn from gene-

ral observation are of no utility, or deceive rather than inform. The difficulty of keeping accounts, which, however commonly neglected, it is allowed never ought to be so, is certainly not inconsiderable. The mode must often be regulated by the nature of the farm. The possessor of open fields, where scraps of land belonging to others are intermingled with his own, can, with extreme difficulty only, keep an account of every part, which, however, it is justly thought of the first importance to do in general, as the knowledge of what every field has paid, in certain circumstances, is the only basis for correct decision on its application. Small fields are from this, as well as from other causes, extremely inconvenient. They are not only inconvenient in preparation, and attended with much loss in borders and ditches, but they derange the accuracy of accounts, if they are not fully noticed, and occupy a great portion of the time of the farmer, if they are. When all the produce of several fields is thrown together, which is far from an uncommon case, some objects, very interesting to be ascertained, must be left entirely to conjecture; and when a comparison is made by guesses, the conclusion formed must be totally invalidated as authority. The separation of crops is therefore an important object, with a view to accounts, and is essential, indeed, to their being kept with accuracy. For the rent, tithes, and parochial rates, three separate accounts thould be kept, but the amount of all should be divided on every field, for which an account should be kept according to the real contents of it. A distinction must be drawn between the gross and net contents of the field; as, otherwise, in the comparison of husbandry, that field might be concluded the most advantageous, which had the least border, and merely for that reason, the cultivation practised in the other being, in fact, more profitable. But detail on this subject is here impracticable, and we must be satisfied with observing that, without correctness of data for a comparison, the conclusions formed will constitute only a catalogue of errors. The article of sundry expenses must universally have place in a well regulated account, and should include whatever payments concern the farm in general, (and are not included in any distinct article) and not any object or field in particular. With respect to the article of wear and tear, the arable lands will swallow up by far the greater proportion of these expenses. As they principally attach to the team, the proper mode of setting them down is, after ascertaining them at so much per pound on the team account, to charge thus proportionally per acre. The land appropriated for feeding grass will have very little concern in them, and that for mowing by no means much. To settle the expense of the team work, the green food for the teams in summer, the hay and oats consumed, the shoeing and farriering, their real decline in value, the pay for attendance, are each to be itemed down separately; and to apportion the whole expense to the work executed by them, a day-book must contain an account of this work every day in the year, with a specification of the field or business they were engaged in. At the end of the year a clear result may be obtained, by proportionally dividing the amount of the expense among the work. The article manure should be arranged under the head farm-yard, and is one of the most complex and difficult. This account should be charged with the price of the straw used in the yard, at what it could be sold for, deducting the carriage, and it should be credited with the price per week of keeping the cattle. All the labour employed in turning over the dung and cleaning the yard is charged to this account. The total expense of the dung, when carted to the land, is divided by the number of loads, giving so much per load: it should be charged the following year on the lands on which it is spread, although the benefit of it is not confined to that single year: but keeping open the account for a longer time would expose to great and inextricable confusion. One of the most complex of all accounts is that of grass lands fed. To reduce the difficulty, one account should be opened for mowing ground, to which all expenses of rent, tithe, taxes, &c. should be carried for every field mown; while its credit consists of the value, at the market price of all the mown produce, as delivered to the cattle of any description. The after grass on these fields must be estimated at a certain sum per acre, and charged to the account of feeding ground. To this account must be carried all the debits of the fields fed, while the credit should consist of all the food of the team, at a certain weekly estimate; and of any cattle taken to joist. The account for sheep, dairy, and fatting beasts, is each to be charged its peculiar expenses; wages, hurdles, shepherd, &c. for the first; fuel and straw, &c. for the second; and the purchase

money of lean stock for fatting beasts. Amidst all this minuteness and complexity of account, order must be produced. The cattle, cows, and sheep, have turnips, with respect to which the estimate of them must be made, not at what they cost, but at what they would sell for eaten off the field, as they cost more than the latter price, and were intended to repay in the crops for which they prepare. The books should be every year balanced, about the season at which the farm was entered upon; and, to avoid arbitrary valuation, the old year's accounts must be continued open considerably after the new ones have commenced, till the fatting beasts and the corn are sold, and those points decided, on which the profit or loss of the former year depended. By these means conjectures may be, in a great degree, precluded, but not altogether, as these must extend to the estimate of the live stock bought and sold within the year, and to the implements of husbandry. The stock must be estimated every year; and in settling this estimate, their worth at the very time of its being made, that is, the price they would then sell for, must be set down. With respect to fatting beasts, cows, and sheep, this proceeding must equally take place. Every year, also, implements should be valued, and the balance must be carried, where alone it is applicable, to the general head of wear and tear.

The minuteness and accuracy necessary for this or any other efficient mode of account may deter many from its adoption, and undoubtedly has this effect on thousands. The want of attention, however, to this subject has, unquestionably, been the cause to which many individuals may justly ascribe their failure in this art, and has operated extremely to check the progress of it in general. The hints suggested will be sufficient to evince its general and particular importance, and induce some, perhaps, to follow up, with care and correctness, a practice, which can alone enable them to give the fair results of interesting experiments, or qualify them to ascertain the particular causes of success or failure in general management: The obscurity and perplexity of conjecture can by such means alone be changed for the clearness of fact and the beauty of order; and, in short, they can thus only decide with truth, and act with confidence.

AGRIMONIA, *agrimony*, in botany, a genus of Dodecandria Dyginia class and order: the calyx is one-leafed, permanent, perianthium fenced with an outer calyx; the corolla has five petals; the stamina are capillary filaments, shorter than the corolla; the anthers are small; the pistillum is a germ inferior; the style simple; the stigmas obtuse; no pericardium; there are two roundish seeds. Of this genus there are five species: the A. parviflora grows in the borders of cornfields, shady places, and hedges, in Great Britain, and most parts of Europe, also in similar places in the United States; it is perennial, and flowers in June and July. The root is sweet-scented; an infusion of it is used by the Canadians with success in burning fevers. Dr. Hill says, that an infusion of six ounces of the crown of the root in a quart of boiling water, sweetened with honey, and drank to the quantity of half a pint, thrice a day , is a cure for the jaundice. When the plant comes into flower, it will dye wool of a bright full nankeen colour; if gathered in September, it yields a darker yellow. In Prussia it is used for dressing of leather. The American species are three in number: 1. A. eupatoria, of which there are two varieties, the hirsuta and the glabra; 2. A. parviflora; 3. A. pumila.

AGROSTEMA, *the garland of the field*, in botany, a genus of the Decandria Pentagynia class and order: the calyx is one-leafed; the corolla has five petals; the stamina are ten awl-shaped filaments; the pistillum an ovate germ, with erect styles and simple stygmas; the pericarpium is one-celled; the seeds are numerous. There are four species, viz. 1. A. githago, corn campion, or cockle: 2. A. coronaria, rose-campion: 3. A. flos jovis: and 4. A. cœli rosa, smooth campion. The first species is a common annual weed in corn fields, and flowers in June or July; the seeds are black, with a surface like shagreen, and appears in the microscope like a hedge-hog rolled up. The second species is biennial, a native of Italy, the Valais, and Siberia; but so long an inhabitant of English gardens, that it is become a kind of weed. Of this plant there are three varieties, one with deep red, another with flesh-coloured, and a third with white flowers; but they are not much esteemed, as the double rose-campion, which is a fine flower, has excluded the others from most good gardens. The single rose-campions are sufficiently propagated by the self-sown seeds. The variety with double flowers, having no seeds, is propagated by parting the roots in autumn, and planting them in a border of fresh undunged earth, at the distance of about

six inches; they should be watered gently till they have taken root; afterwards wet, as well as dung, is injurious to them. In spring they should be removed into the borders of the flower-garden, where they will be very ornamental whilst they flower in July and August. The third species grows naturally on the Swiss and Piedmontese mountains, and in the Palatinate, and was cultivated in 1739, by Mr. Miller. It flowers in July, and the seeds ripen in September. It will thrive best in a moist soil, and a shady situation. The fourth species is annual. It is a native of Italy, Sicily, and the Levant, but being a plant of little beauty, it is preserved in botanic gardens merely for variety.

AGROSTIS, *bent-grass*, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is composed of a glume, consisting of two valves, and inclosing a single flower; it is of an acuminated figure; the corolla is also of an acuminated figure, and composed of two valves; it is scarce so long as the cup, and one of the valves is larger than the other, and aristated; the corolla serves in place of a pericarpium; it surrounds and every way incloses the seed, which is single, roundish, and pointed at each end.

There are 42 species, distributed into two classes; the aristatæ, or those with awns; and the muticæ, or naked without awns. The A. spica venti, silky bent grass, with entire petals, the outer one having a stiff, straight, and very long awn, and the panicle spreading; is an annual, and common in sandy corn-fields. It flowers in June and July, and is liable to be smutted. Horses and goats eat it, but sheep refuse it. The A. arundicea, furnished with a writhed awn; is a native of many parts of Europe, and is a perennial. The Kalmuc Tartars weave mats of it, and thatch their houses with it. The alba, or white bent-grass, is perennial, and grows in ditches, marshes, and moist meadows: there are four varieties, some of which are found among potatoes in light sandy soils, and some among wheat, flowering from July to September.

AGUE. See MEDICINE.

AGYNEIA, in botany, a genus of the Triandria Monogynia class and order: the male flowers are below the female, the calyx is six-leaved; no corolla; in the male, instead of filaments, are three or four anthers: in the female flowers, the germ of the size of the calyx; neither style nor stigma. There are two species, viz. A. impubes, with leaves smooth on both sides; and A. pubera, with leaves downy underneath: both species are natives of China.

AID *de-camp*, in military affairs, an officer employed to receive and carry the orders of a general. He ought to be alert in comprehending, and punctual and distinct in delivering them. He is seldom under the degree of a captain, and all aids-de-camp have ten shillings a day allowed for their duty.

AIGUISCE, AIGUISSE, EGUISCE, in heraldry, denotes a cross with its four ends sharpened, but so as to terminate in obtuse angles.

It differs from the cross fitchée, in as much as the latter goes tapering by degrees to a point, and the former only at the ends.

AILANTHUS, in botany, a genus of plants of the Decandria Trigynia class and order; it has male, female, and hermaphrodite flowers. The calyx of the male is one-leafed; the corolla has five petals: the stamina have ten filaments, the anthers are oblong and versatile. The calyx and corolla of the female are the same as those of the male; the pistillum has from three to five germs; the styles are lateral, and the stigmas capitate; the pericardium has as many capsules as there are germs; the seeds are solitary. The calyx and corolla of the hermaphrodite are the same with those of the male and female; the stamina have two or three filaments; the pistillum, pericarpium, and seed, as in the female. There is one species, viz. A. glandulosa, or tall ailanthus, which is a tree with a straight trunk, forty or fifty feet high, a native of China. It grows fast in our climate, and, as it rises to a considerable height, it is proper for ornamental plantations. A resinous juice, which soon hardens, flows from the wounded bark. The wood is hard, heavy, glossy, like satin, and susceptible of a fine polish.

AILE, or AIEL, in law, a writ which lies where a person's grandfather, or great grandfather, being seised of lands, &c. in fee-simple the day that he died, and a stranger abates or enters the same day, and dispossesses the heir of his inheritance.

AJOVEA, in botany, a genus of the Hexandria Monogynia class and order: the calyx is single-leaved, the corolla has three petals, the stigma is divided into six segments, and the fruit is a roundish, single-celled, monospermous berry. There is one species that grows in the forests of Guiana.

AIR, a thin elastic fluid, surrounding the globe of the earth. It is compounded principally of two gasses, viz. oxygen and azote, together with a variety of other substances, suspended or dissolved therein. The mechanical and chemical effects of this extensive fluid mass are discussed under various heads of science. See ATMOSPHERE, CHEMISTRY, and the articles thence referred to.

AIR, in music, generally speaking, is any melody, the passages of which are so constructed as to lie within the province of vocal expression, or which, when sung or played, forms that connected chain of sounds which we call tune. The strict import of the word is confined to vocal music, and signifies a composition written for a single voice, and applied to words.

AIR-*gun*, a machine for exploding balls by means of condensed air.

Authors describe two kinds of this machine, viz. the common one, and what is called the magazine air-gun. See PNEUMATICS.

AIR-*pipes*, a contrivance invented by Mr. Sutton, a brewer of London, for clearing the holds of ships, and other close places of their foul air. The principle upon which this contrivance is founded is well known. It is no other than the rarefying power of heat, which, by causing a diminution of the density of the air in one place, allows that which is in contact with it to rush in, and to be succeeded by a constant supply from remoter parts, till the air becomes every where equally elastic. If a tube, then, be laid in the well-hold, or any other part of a ship, and the upper part of this tube be sufficiently heated to rarefy the impending column of air, the equilibrium will be maintained by the putrid air from the bottom of the tube, which, being thus drawn out, will be succeeded by a supply of fresh air from the other parts of the ship; and by continuing the operation, the air will be changed in all parts of the ship. Upon this principle, Mr. Sutton proposed to purify the bad air of a ship by means of the fire used for the coppers, or boiling places, with which every ship is provided. Under every such copper or boiler there are two holes, separated by a grate, one for the fire and the other for the ashes; and there is also a flue, communicating with the fire place, for the discharge of the smoke. The fire, after it is lighted, is preserved by the constant draught of air through these two holes and the flue; and if the two holes are closed, the fire is extinguished. But when these are closed, if another hole, communicating with any other airy place, and also with the fire, be opened, the fire will of course continue to burn. In order to clear the holds of the ships of the bad air, Mr. Sutton proposed to close the two holes above mentioned, viz. the fire-place and ash-place, with substantial iron doors, and to lay a copper or leaden pipe, of sufficient size, from the hold into the ash-place, and thus to supply a draught of air for feeding the fire; a constant discharge of air from the hold will be thus obtained, and fresh air will be supplied down the hatches, and by such other communications as are open into the hold. If other pipes are connected with this principal pipe, communicating either with the wells or lower decks, the air that serves to feed the fire will be drawn from such places.

AIR-*shafts*, among miners, are holes made from the open air to meet the adits, and supply them with fresh air.

These, when the adits are long, or exceeding thirty or forty fathoms, become highly necessary, as well to give vent to the damps and noxious vapours, as to let in fresh air.

AIR-*trunk*, a simple contrivance by Dr. Hales, for preventing the stagnation of putrid effluvia, and purifying the air in jails and close rooms; which consists of a square trunk, open at both ends, one of which is fixed in the ceiling, and the other is extended to a considerable height above the roof. The noxious effluvia, ascending to the top of the room, escape by this trunk. Some of these have been nine, and others six, inches in the clear; but, whatever be their diameter, their length should be proportional, in order to promote the ascent of the vapour. As the pressure of fluids, and consequently of the air, corresponds to their perpendicular altitude, the longer these trunks are, so much the greater will be the difference between columns of air pressing at the bottom and at the top; and of course so much the greater will be their effect. See VENTILATOR.

AIR-*vessel*, in hydraulics, is a name given to those metalline cylinders, which are placed between the two forcing-pumps in the improved fire-engines. The water is injected by the action of the pistons through two pipes, with valves, into this vessel; the air previously contained in it will be compressed by the water, in proportion to the quantity admitted, and by its spring force the water into a pipe, which will discharge a con-

stant and equal stream; whereas, in the common squirting engine, the stream is discontinued between the several strokes. Other water-engines are furnished with vessels of this kind.

Air-*vessels*, in botany, are certain canals or ducts, whereby a kind of absorption and respiration is effected in vegetable bodies.

Air-vessels have been distinguished from sap-vessels; the former being supposed to correspond to the trachea and lungs of animals; the latter to their lacteals and blood-vessels.

Dr. Grew, in an inquiry into the motion and cause of the air in vegetables, shews, that it enters them various ways, not only by the trunk, leaves, and other parts above ground, but at the root. For the reception, as well as expulsion of the air, the pores are so very large in the trunks of some plants, as in the better sort of thick walking-canes, that they are visible to a good eye without a glass; but with a glass, the cane seems as if it were stuck full of large pin-holes, resembling the pores of the skin in the ends of the fingers, and ball of the hand. In the leaves of the pine, through a glass, they make an elegant shew, standing almost exactly in rank and file throughout the length of the leaves. But though the air enters in partly at the trunk, and also at other parts, especially in some plants, yet its chief admission is at the root: much as, in animals, some part of the air may continually pass into the body and blood by the pores of the skin; but the chief draught is at the mouth. If the chief entrance of the air were at the trunk, before it could be mixed with the sap in the root, it must descend; and so move not only contrary to its own nature, but in a contrary course to the sap: whereas, by its reception at the root, and its transition from thence, it has a more natural and easy motion of ascent. The same fact is farther deduced from the fineness and smallness of the diametral apertures in the trunk, in comparison of those in the root, which nature has plainly designed for the separation of the air from the sap, after they are both together received into them.

Air-vessels are found in the leaves of all plants, and are even discoverable in many without the help of glasses; for, upon breaking the stalk or chief fibres of a leaf, the likeness of a fine woolly substance, or rather of curious small cobwebs, may be seen to hang at both the broken ends. This is taken notice of, not only in some few plants, as in scabious, where it is most visible: but may also be seen more or less in most others, if the leaves be very tenderly broken. This wool is really a skein of air-vessels, or rather of the fibres of the air-vessels, loosed from their spiral position, and so drawn out in length.

AIRA, *hair-grass*, in botany, a genus of the Triandria Digynia class and order, and of the natural order of Grasses. There are twenty-five species, some of which have awns, and others have none. The A. aquatica, water hair-grass, generally grows in the margin of pools and watery places, running into the water to a considerable distance, and is known by the purple or bluish colour of the pannicles, and sweet taste of the flowers. It is a perennial, and flowers in May and June. To this grass has been attributed the sweetness of Cottenham cheese, and the fineness of Cambridge butter. The A. cæpitosa, or tufty-hair grass, grows in moist meadows and woods, is perennial, it flowers in June and July, sometimes trailing on the ground to the length of several feet, and the panicle exhibiting a beautiful silky appearance: cows, goats, and swine eat it, but horses are not fond of it. It is the roughest and coarsest grass that grows in pastures or meadows, and is called by the common people hassocks, rough-caps, and bull's faces. To get rid of it, the land should be first drained, and the tufts of the noxious weeds pared off and burnt The ashes yield a good manure. The A. flexuosa, or waved mountain grass, is the principal grass on Banstead Downs, and the Mendip Hills. It is difficult of cultivation.

AITONIA, in botany, so called from Mr. Aiton, his Majesty's late gardener at Kew, a genus of the Monadelphia Octandria class and order, and of the natural order of Columniferæ. There is but one species, viz. A. capensis, found at the Cape of Thunberg. It has a shrubby stalk, six feet high, and a fruit resembling that of the winter cherry. With us it is of slow growth, and seldom exceeds three feet in height. At a sufficient age it produces flowers and fruit through the greatest part of the year.

AJUGA, *bugle*, in botany, a genus of the Didynamia Gymnospermia class of plants: the flower is monopetalous and ringent; the upper lip being small and bifid; the lower one large and trifid: there is no pericarpium: the seeds are contained in the cup of the flower, and are four in number. There are 10 species. The species native in the United States are 7

in number, 1. A. Cerpitosa; 2. A. flexuosa; 3. A pallens, of which there are two varieties, one with and the other without *awns;* 3. A. truncata: 5. A. mollis; 6. A. purpurea of Walt: 7. A. præcox. There is an eighth doubtful species, A. aegytopoides of Walt.

AIZOON, in botany, a genus of the Polyandria Pentagynia: the calyx is a one-leafed perianthium: no corolla; the stamina have many capillary filaments; the anthers are simple, the pistillum has a five-cornered germ, the seeds are several: there are ten species, all belonging to the hot climates.

ALA, in botany, is used in different senses; sometimes it denotes the hollow between the stalk of a plant and the leaves; sometimes it is applied to the two side petals of the papilionaceous flowers, the upper petal being called the vexillum, and the lower one the carina; others use it for the slender membranaceous parts of some seeds, thence said to be alated; and others, again, for the membranaceous expansions found on the stems of plants, thence denominated alated stalks.

ALABASTER, a well known description of stone used by statuaries and others. It is the sulphate of lime. See CHEMISTRY and MINERALOGY.

ALÆ, in anatomy, is sometimes used for the lobes of the liver, the nymphæ of the female pudendum, the two cartilages which form the nostril, the arm-pits, young stems or branches, &c.

ALANGIUM, in botany, a genus of the Decandria Monogynia class and order: the characters of which are, that it has from 6 to 10 linear petals, from 10 to 12 stamina; the calyx dentated; the fruit a spherical berry, single-celled, containing from one to three seeds: there is only one species, viz. A. pungens.

ALATED, in botany, an epithet applied to the seed, stem, or leaf-stalk; a seed is alated, when it has an ala or membrane affixed to it, which, by its flying, serves to disperse it. The foot stalk of a leaf is alated, when it spreads out the sides. Alated leaves are those made up of several pinnated ones.

ALAUDA, *lark*, in ornithology, a genus of birds of the order of Passeres; the characters of which are, that the beak is cylindrical, subulate, and straight, bending towards the point, the mandibles are of equal size, and opening downwards at their base; the tongue is bifid; and the hinder claw is straighter and longer than the toe. Pennant adds, that the nostrils are covered with feathers or bristles, and the toes divided to their origin. There are 33 species, but we shall notice only two of them. 1. A. arvensis, or sky-lark, the specific characters of which are, that the two outermost quills of its tail are white lengthwise externally, and the intermediate ones are ferruginous on the inside: the length is about seven inches. The males of this species are somewhat browner than the females; they have a black collar, and more white on the tail; their size is larger, and their aspect bolder; and they exclusively possess the faculty of singing. When the female is impregnated, she forms her nest between two clods of earth, and lines it with herbs and dry roots, being no less attentive to the concealment than to the structure of it. It sometimes builds its nest among corn and in high grass. Each female lays four or five eggs, which are greyish, with brown spots; and the period of her incubation is about 15 days. The young may be taken out of the nest when they are a fortnight old, and they are so hardy, that they may be easily brought up. The parent is very tender of her young; and though she does not always cover them with her wings, she directs their motions, supplies their wants, and guards them from danger. The common food of the young sky-larks is worms, caterpillars, ant's eggs, and even grasshoppers; and in maturity they live chiefly on seeds, herbage, and all vegetable substances. Those birds, it is said, that are destined for singing, should be caught in October or November; the males should, as much as possible, be selected: and when they are untractable, they should be pinioned, lest they injure themselves by their violence against the roof of the cage. As they cannot cling by the toes, it is needless to place bars across their cage; but they should have clean sand at the bottom of it, that they may welter in it, and be relieved from the vermin which torment them. In Flanders, the young ones are fed with moistened poppy-seeds and soaked crumbs of bread; and, when they begin to sing, with sheep's and calves' hearts, hashed with hard eggs; to which are added, wheat, spilt-oats, millet, linseed, and the seeds of poppy and hemp, steeped in milk. Their capacity of learning to sing is well known; and so apt are some cock larks, that, after hearing a tune whistled with the pipe, they have caught the whole, and repeat it more agreeably than any linnet or canary bird. In summer the lark seeks the highest and driest

situations; but in winter they descend to the plains, and assemble in numerous flocks. In the former season they are very lean, and in the latter very fat, as they are always on the ground, and constantly feeding. In mounting the air, they ascend almost perpendicularly, by successive springs, and hover at a great height; but in descending, they make an oblique sweep, unless they are pursued by a ravenous bird, or attracted by a mate, in either of which cases they fall like a stone. These small birds, at the height to which they soar, are liable to be wafted by the wind; and they have been observed at sea, clinging to the masts and cordage of ships. Sir Hans Sloane observed some of them 40 miles from the coast, and Count Marsigli met with them on the Mediterranean. It is conjectured that those which are found in America have been driven thither by the wind. Some have supposed, that they are birds of passage, at least in the more southern and milder climates of Europe; but they are occasionally concealed under some rock or sheltered cave. The lark is found in all the inhabited parts of both continents, as far as the Cape of Good Hope; this bird, and the wood-lark, are the only birds which sing whilst they fly. The higher it soars, the more it strains its voice, and lowers it till it quite dies away in descending. When it ascends beyond our sight, its music is distinctly heard; and its song, which is full of swells and falls, and thus delightful for its variety, commences before the earliest dawn. In a state of freedom, the lark begins its song early in the spring, which is its season of love and pairing, and continues to warble during the whole of the summer. The honourable Daines Barrington reckons this among the best of the singing larks; and as it copies the warble of every other bird, he terms it a mocking-bird. These birds, which are esteemed a delicacy for the table, though Linnæus thinks the food improper for gravelly complaints, are taken with us, in the greatest numbers, in the neighbourhood of Dunstable. The season begins about the 14th of September, and ends the 25th of February; and during this time, about 4000 dozen are caught, for supplying the London markets. Those caught in the day are taken in clap-nets, till the 14th of November. But when the weather becomes gloomy, and also in the night, the larker makes use of a trammel-net, 27 or 28 feet long, and five broad, which is put on two poles 18 feet long, and carried by men under each arm, who pass over the fields, and quarter the grounds, as a setting dog. When they see or feel a lark strike the net, they drop it down, and thus the birds are taken. The darkest nights are the most proper for their sport; and the net will not only take larks, but all other birds that roost on the ground; among which are woodcocks, snipes, partridges, quails, fieldfares, and several others. In the depth of winter, people sometimes take great numbers of larks by nooses of horse-hair. The method is this: take 100 or 200 yards of packthread; fasten at every six inches a noose made of double horse-hair; at every 20 yards the line is to be pegged down to the ground, and so left ready to take them. The time to use this is when the ground is covered with snow, and the larks are to be allured to it by some white oats, scattered among the nooses. They will soon fly to them, and, in eating, will be hung by the nooses. They must be taken away as soon as three or four are hung, otherwise the rest will be frightened; but though the others are scared away just where the sportsman comes, some will be feeding at the other end of the line, and the sport may be thus continued for a long time. As the sky-lark is a kind of mocking-bird, and apt to catch the note of any other which hangs near it, even after its own note is fixed, the bird-fanciers often place it next to one which has not been long caught, in order to keep the caged sky-lark honest. Plate II. Aves, fig. 1.

2. A. arborea, wood-lark of English writers, is specifically characterised by a white annular belt, encircling its head. This bird is smaller than the sky-lark, and of a shorter thicker form; the colours of the plumage are paler; the first feather of the wing is shorter than the second; the hind claw is very long and somewhat bent; it perches on trees; it haunts the uncultivated tracts near copses, without penetrating the woods, whence its name; its song resembles more the warble of the nightingale, or the whistling of the black-bird, than that of the sky-lark, its note being less sonorous and less varied, though not less sweet; and it is heard not only in the day, but in the night, both when it flies and when it sits on a bough. This bird builds on the ground, and forms its nest on the outside with moss, and on the inside with dried bents, lined with a few hairs, and conceals it with a turf; and the situation it selects is ground where the grass is.

rank, or become brown. It lays four or five eggs, which are dusky and blotched with deep brown; its fecundity is inferior to that of the sky-lark, and its numbers are not so great: it breeds earlier, since its young are sometimes flown in the middle of March, and therefore they pair in February, at which time, and not before, they part with their last year's brood; whereas the common lark does not hatch before the month of May. This is a very tender and delicate bird; so that it is impossible to rear the young taken out of the nest: but this is the case only in England and such cold climates, for in Italy they are removed from the nest, and reared at first like the nightingale, and afterwards fed upon panic and millet. The wood-lark feeds on beetles, caterpillars, and seeds: its tongue is forked; its stomach muscular and fleshy; and it has no craw, but a moderate dilatation of the lower part of the œsophagus, and its cœca are very small. It lives ten or twelve years. The males are distinguished from the females by their larger size; the crown of the head is also of a darker colour, and the hind nail longer; its breast is more spotted, and its great wing-quills edged with olive, which in the female is grey. The wood-lark mounts high, warbling its notes, and hovering in the air; it flies in flocks during the winter colds; it is found in Sweden and Italy, and is probably dispersed through the intervening countries, and consequently over the greatest part of Europe. It is also found in Siberia, as far as Kamtschatka, and likewise in the island of Madeira. The best time for taking this bird for the cage is July, or the preceding or following month. Those that are put into the cage at this time sing presently; but their song-time is not lasting, for they soon fall to moulting, in which state many die; but if they get over it, they commonly prove very healthful afterwards, become very tame and familiar, and sing sweetly. Those which are taken in the latter end of September are generally very strong and sprightly; but they do not sing till after Christmas. Those taken in January and February finally prove the best of all; they generally begin singing in two or three days, or at the utmost in a week after they are taken. The cock-bird of this kind is known from the hen by the loudness and length of his call, by his tallness as he walks about the cage, and by his doubling his notes in the evening, as if he were going with his mate to roost. A better rule than all others, however, is his singing strong; for the hen wood-lark sings but very weakly. Both the cock and hen of this kind are tender, and subject to many disorders; the principal of these are, cramps, giddiness of the head, and breeding lice. Cleanliness is the best cure for the first and the last of these complaints; but we know of no cure for the other. A good strong bird will last very well for five or six years, and frequently improve during the whole of this time. The lark is not only a very agreeable bird for the cage, but it will also live upon almost any food, so that it have once a week a fresh tuft of three-leaved grass put into the cage with it. The wood-lark is one of the sweetest of our singing-birds, and is indeed very little inferior to the nightingale, when in good health; but we are not to judge by such as are made feeble by improper food, or want of cleanliness in their cages.

ALBINOS, in zoology, a denomination given to the white negroes of Africa, who have light hair, blue eyes, and a white body, resembling that of the Europeans, when viewed at a distance; but upon a nearer approach, the whiteness is pale and livid, like that of leprous persons, or of a dead body. Their eyes are so weak that they can hardly see any object in the day, or bear the rays of the sun, and yet, when the moon shines, they see as well, and run through the deepest shades of their forests with as much ease and activity, as other men do in the brightest day-light. Their complexion is delicate; they are less robust and vigorous than other men; they generally sleep in the day, and go abroad in the night. The negroes regard them as monsters, and will not allow them to propagate their kind. In Africa this variety of the human species very frequently occurs. Wafer informs us, that there are white Indians of the same general character among the yellow or copper-coloured Indians of the isthmus of Darien. It has been a subject of inquiry, whether these men form a peculiar and distinct race, and a permanent variety of the human species, or are merely individuals who have accidently degenerated from their original stock. Buffon inclines to the latter opinion, and he alleges in proof of it, that in the isthmus of America a husband and wife, both of a copper colour, produced one of these white children; so that the singular colour and constitution of these white

Indians must be a species of disease which they derive from their parents; and the production of whites by negro parents, which sometimes happens, confirms the same theory. According to this author, white appears to be the primitive colour of nature, which may be varied by climate, food, and manners, to yellow, brown, and black; and which, in certain circumstances, returns, but so much altered, that it has no resemblance to the original whiteness, because it has been adulterated by the causes that are assigned. Nature, he says, in her most perfect exertions, made men white; and the same nature, after suffering every possible change, still renders them white: but the natural or specific whiteness is very different from the individual or accidental. Of this we have examples in vegetables, as well as in men and other animals. A white rose is very different, even in the quality of whiteness, from a red rose, which has been rendered white by the autumnal frosts. He deduces a farther proof that these white men are merely degenerated individuals, from the comparative weakness of their constitution, and from the extreme feebleness of their eyes. This last fact, he says, will appear to be less singular, when it is considered that in Europe very fair men have generally weak eyes; and he has remarked that their organs of hearing are often dull: and it has been alleged by others, that dogs of a perfectly white colour are deaf. This is a subject which demands farther investigation. Buffon's Natural History.

ALBUCA, in botany, a genus of the Hexandria Monogynia class and order: corolla six-petalled; the inner ones connivent; outer ones spreading; style triangular: this genus is distinguished into those species, three of whose stamina are fertile; and into others, in which all the stamina and fertile: of the former there are six species; of the latter eight. They are all found at the Cape.

ALBUMEN, in chemistry, a term to denote the white of egg, and all glary, tasteless substances, which, like it, have the property of coagulating into a white, opaque, tough, solid substance, when heated a little under the boiling point. This substance forms a constituent of many of the fluids of animal bodies, and when coagulated, it constitutes also an important part of their solids. Substances analogous to it have been noticed in the vegetable kingdom. The essential characters of albumen are the following: 1. In its natural state it is soluble in water, and forms a glary, limpid liquid, having very little taste: in this state it may be employed as a paste and a varnish. 2. The solution is coagulated by acids, in the same way as milk is acted upon; and also by heat of the temperature of 170°, and by alcohol. 3. Dissolved in water, it is precipitated by the infusion of tan; and also in the form of white powder by the salts of most of the white metals, as silver, mercury, lead and tin. 4. When burnt it emits ammonia, and when treated with nitric acid, yields azotic gas. The juice of the papaw tree yields albumen; so also does the juice of the fruit of the hibiscus esculentis: that obtained from the latter has been used in the West Indies as a substitute for white of eggs in clarifying sugar.

ALBURNUM, denotes the white, soft substance that lies between the inner bark and the wood of trees, composed of layers of the former, which have not attained the solidity of the latter. Plants, after they have germinated, do not remain stationary, but are continually increasing in size. A tree, for instance, every season adds considerably to its bulk. The roots send forth new shoots, and the old ones become longer and thicker. The same increment takes place in the branches and the trunk. A new layer of wood, or rather of alburnum, is added annually to the tree in every part, just under the bark; and the former layer of alburnum assumes the appearance of perfect wood. The alburnum is found in largest quantities in trees that are vigorous; though in such as languish and are sickly there is a great number of beds. In an oak six inches in diameter the alburnum is said to be nearly equal in bulk to the wood.

ALCA, *auk*, in ornithology, a genus of the order of Anseres, in the Linnæan system, the characters of which are, that the bill is without teeth, short, compressed, convex, frequently furrowed transversely; the inferior mandible is gibbous before the base; the nostrils are behind the bill; and the feet have generally three toes. This genus comprehends 12 species, of which we shall notice the following: A. torda, with four furrows on the bill, and a white line on each side, running from the bill to the eyes. This is the alca of Clusius and Brisson; the pinguin of Buffon; and the razor-bill, auk, or murre, of Pennant, Ray, Willoughby, Albinus, Edwards, and Latham. This species weighs about 22½ ounces; its length is about 18 inches,

and breadth 27. These birds, in company with the guillemot, appear in our seas in the beginning of February, but do not settle in their breeding-places till they begin to lay, about the beginning of May. When they take possession of the ledges of the highest rocks that hang over the sea, they sit close together, and in rows one above another, and form a very grotesque appearance. They lay only one egg at a time, which is of a large size, in proportion to that of the bird, being three inches long, either white or of a pale sea-green, irregularly spotted with black: if this egg be destroyed, both the auk and the guillemot will lay another, and if this be taken, a third; as they make no nest, they deposit the egg on the bare rock, poising it in such a manner as no human art can effect, and fixing it by means of the viscous moisture that bedews its surface on its exclusion; and though such multitudes of eggs are contiguous to each other, each bird distinguishes its own. These eggs serve as food to the inhabitants of the coasts which the birds frequent; and are procured with great hazard by persons let down with ropes, held by their companions, and who, for want of stable footing, are sometimes precipitated down the rocks, and perish together. They are found in the northern parts of America, Europe, and Asia They come to breed on the Ferroe islands, along the west of England, and on the Isle of Wight, where they add to the multitude of sea-fowl that inhabit the great rocks called the Needles. Their winter residence is not positively ascertained. As they cannot remain on the sea in that season, and never appear on shore, nor retire to southern climates, Edwards supposes that they pass the winter in the caverns of rocks, which open under water, but rise internally as much above the level of the flood as to admit a recess, and here, as he apprehends, they remain torpid, and live upon their abundant fat. The pace of this bird is heavy and sluggish; and its ordinary posture is that of swimming or floating on the water, or lying stretched on the rocks, or on the ice.

A. impennis, A. major of Brisson, penguin of Ray, Martin, Edwards. &c. and great auk of Pennant and Latham, has its bill compressed and furrowed on both sides, and has an oval spot on each side before the eyes. Its length to the end of its toes is three feet; the bill to the corner of the mouth is 4¼ inches: the wings are so small as to be useless for flight; their length, from the tip of the longest quill-feathers to the first joint, being only 4¼ inches: and these birds are therefore observed by seamen never to wander beyond soundings, and by the sight of them they are able to ascertain the nearness of the land. They can scarcely even walk, and of course continue on the water, except in the time of breeding. According to Mr. Martin, they breed on the isle of St. Kilda, appearing there in the beginning of May, and retiring in the middle of June. They lay one egg, six inches long, of a white colour: and if the egg be taken away, no other is laid in the same season. Mr. Macaulay, in his history of St. Kilda, observes, that this bird does not visit that island annually, but sometimes keeps away for several years together, and that it lays its eggs close to the sea-mark, and is incapable, by the shortness of its wings, of mounting higher. Birds of this species are said not to be numerous; they seldom appear on the coasts of Norway. They are met with near Newfoundland and Iceland. They do not resort annually to the Ferroe Islands, and they rarely descend more to the south in the European seas. They feed on the cyclopterus and such fish, and on the rose-root and other plants. The skins are used by the Esquimaux for garments. These birds live in flocks at sea, and never approach the land, except in very severe cold; and in this case they are so numerous, that they cover the water like a thick dark fog. The Greenlanders drive them on the coast, and catch them with the hand, as they can neither run nor fly. At the mouth of the Ball river they afford subsistence to the inhabitants in the months of February and March, and their down serves to line winter garments. Plate II. Aves, fig. 2.

A. psittacula, or perroquet auk of Pennant and Latham, is found in the sea that lies between the northern parts of Asia and America, sometimes by day in flocks swimming on the water, though not very far from land, unless driven out by storms, and in the night harbouring in the crevices of rocks. About the middle of June they lay upon the rocks or sand a single egg, about the size of that of a hen, and of a dirty white or yellowish colour, spotted with brown, which is esteemed good. These birds, like others of the same class, are stupid, and are mostly taken by the natives, who place themselves in the evening among the rocks, dressed in garments of fur with large open sleeves, into which the birds fly for shelter as the night comes on, and thus they become

an easy prey. They sometimes at sea mistake a ship for a roosting place, and thus warn navigators of their being near the land, at the access of night, or on the approach of storms.

A. cirrhata, tufted auk of Pennant and Latham, is entirely black, nearly 18 inches long, swimming about for whole days in the sea, where it dives well, and occasionally flies swiftly, but never departing far from the rocks and islands, and feeding on shrimps, crabs, and other shell-fish, which it forces from the rocks with its strong bill; in the night it comes to shore, burrows about a yard deep under ground, and makes a nest with feathers and sea-weed, in which it lodges with its mate, being monogamous. It lays one egg in May or June, which is fit to be eaten and used for food, but the flesh of the bird is hard and insipid. This species inhabits the shores of Kamtschatka, the Kurile islands, and those that lie between Kamtschatka and America.

A. arctica, or puffin, found on the coasts of England; and particularly in Prestholm isle, where they are seen in flocks almost innumerable. They come in the beginning of April, and depart in August. Fig. 3.

ALCEA, *hollyhock*, in botany, a genus of the Monadelphia Polyandria class of plants, the calyx of which is a double perianthium; the exterior one, which is permanent, consists of a single patent leaf, divided into six segments; the interior is also permanent, and consists of a single leaf divided into five segments: the corolla consists of five very large patent and emarginated petals, growing together at the base: the fruit is composed of numerous capsules, each containing a single compressed kidney-shaped seed. There are five species. The hollyhock grows wild in the country of Nice. The colour of the flowers is accidental, and the double flowers are only varieties proceeding from culture. These varieties are not constant; but the greatest number of plants, produced from seeds carefully saved from the most double flowers, will arise nearly the same with the plants from which they are taken, provided they are kept separate from single or bad coloured flowers. The A. rosea grows naturally in China; a dwarf sort, with beautiful double variegated flowers, has been some years in great esteem, under the name of the Chinese hollyhock. Hollyhocks are propagated from seeds, sown half an inch deep in a bed of light earth, about the middle of April. When the plants have put out six or eight leaves, they are to be transplanted into nursery beds, and in October they are to be removed to the situation where they are to remain.

ALCEDO, *kingsfisher*, in ornithology, a genus of the order of Picæ. The characters are, that the bill is three-sided, thick, straight, long, and pointed; the tongue is fleshy, very short, flat, and sharp, and the feet are for the most part gressory. There are 41 species. These birds are dispersed over the whole globe, inhabiting chiefly the water, and living upon fish, which they catch with surprising alertness, and swallow whole, rejecting afterwards the undigested parts; though their wings are short, they fly swiftly; their prevailing colour is sky blue; their nostrils are small, and generally covered. A. ispida, ispida of Gesner and Ray, European kingsfisher of Pennant, and common kingsfisher of Latham, is the only one we shall notice: it is short-tailed, sky-blue above, fulvous below, and its straps are rufous. This bird is 7 inches long and 11 broad, of a clumsy shape, the head and bill being very large, and the legs disproportionately small. The kingsfisher frequents the banks of rivers, and feeds on fish. It takes its prey somewhat in the manner of the osprey, balancing itself at a certain distance over the water for some time, and then darting below the surface, brings the prey up in its feet. When it remains suspended in the air, in a bright day, the plumage exhibit a most beautiful variety of the most dazzling and brilliant colours. It makes its nest in holes in the sides of the cliffs, which it scoops to the depth of three feet, and lays from three to nine eggs, of a very beautiful semi-transparent white. The nest is very fœtid, on account of the refuse of fish with which the young are fed. It begins to hatch its young early in the season, and excludes the first brood in the beginning of April. Whilst the female is thus employed, the male is unremitting in his attention, supplying his mate with fish in such abundance, that she is found at this season plump and fat. He ceases to twitter at this time, and enters the nest as quietly and privately as possible. The young are hatched in about 20 days; but differ both in size and beauty. Some have even doubted, whether the kingsfisher of the moderns and the alcyon of the ancients are the same bird. But the description of Aristotle sufficiently identifies them. The alcyon, says that philosopher, is not much larger than a

sparrow; its plumage is painted with blue and green, and lightly tinged with purple; these colours are not distinct, but melted together, and shining variously over the whole body, the wings, and the neck; its bill is yellowish, long, and slender. The habits of these birds also resemble one another. The alcyon was solitary and pensive; and the kingsfisher is almost always seen alone, and the pairing season is of short duration. The former was not only an inhabitant of the sea-shore, but haunted the banks of rivers; and the latter has also been found to seek shell-fish and large worms, that abound on the shore of the sea, and in rivulets that flow into it. The alcyon was seldom seen, and rapid in its flight; it wheeled swiftly round ships, and instantly retired into its little grot on the shore. The same character belongs also to the kingsfisher. The alcyon and the kingsfisher have the same mode of taking their prey, by diving vertically upon it. The kingsfisher is the most beautiful bird in our climates, as to the richness and luxuriance of the colours of its plumage. It has, says Buffon, all the shades of the rainbow, the brilliancy of enamel, and the glossy softness of silk; and Gesner compares the glowing yellow red, which colours the breast, to the red glare of a burning coal; and yet the kingsfisher has strayed from those climates, where its resplendent and glowing colours would appear to the greatest advantage. There is a species that is common in all the islands of the South Sea; and Forster, in his observations on Captain Cook's second voyage, has remarked, that its plumage is much more brilliant between the tropics than in the regions situated beyond the temperate zone, in New Zealand. In the language of the Society Islands, the kingsfisher is called Erooro, and at Otaheite it is accounted sacred, and not allowed to be taken or killed. Kingfishers were found, not only at Otaheite, but in Huaheine and Ulietea, and in the islands that are scattered over the South Sea, though they are more than 1500 leagues distant from any continent. These kingsfishers are of a dull green, with a collar of the same about their neck. The islanders entertain a superstitious veneration for them. The chief at Ulietea intreated Capt. Cook's companions, in a very serious tone, to spare the kingsfishers and herons of his island, giving permission to kill all the other birds. There are 20 species in Africa and Asia, and eight more that are known in the warm parts of America. The European kingsfisher is scattered through Asia and Africa: many of those sent from China and Egypt are found to be the same with ours, and Belon has met with them in Greece and in Thrace. This brid, though it derives its origin from the hottest climates, bears the rigour of our seasons. It is seen in the winter along the brooks, diving under the ice, and emerging with its prey. The Germans have called it eissvogel, or ice-bird; and it has been found even among the Tartars and Siberians. The Tartars and Ostiacs use the feathers of these birds for many superstitious purposes. The former use them as love amulets; pretending that those which float on water will induce a woman who is touched with them to fall in love with the person who thus applies it. The Ostiacs take the skin, the bill, and the claws of this bird, and enclose them in a purse; and whilst they preserve this amulet, they think they have no ill to fear. Credulity has admitted and reported many other similar tales concerning the extraordinary powers and virtues of this bird; but it is needless to recite them. Its flesh has the odour of musk, and is unpalatable. Plate II. Aves, fig. 4.

ALCHEMY, that branch of chemistry, which had for its principal objects the transmutation of all the metals into gold: the panacea, or universal remedy for all diseases; and the alkahest, or universal menstruum. Those who pursued these delusive projects gradually assumed the form of a sect, under the name of Alchemists, a term made up of the word chemist, and the Arabian article *al* as a prefix. The alchemists laid it down as a first principle, that all metals are composed of the same ingredients, or that the substances at least which compose gold exist in all metals, and are capable of being obtained from them. The great object of their researches was, to convert the baser metals into gold. The substance which produced this property they called *lapis philosophorum*, "the philosopher's stone;" and many of them boasted that they were in possession of that grand instrument. The alchemists were established in the west of Europe as early as the ninth century; but between the eleventh and fifteenth alchemy was in its most flourishing state. The principal alchemists were, Albertus Magnus, Roger Bacon, Arnoldus de Villa Nova, Raymond Lully, and the two Isaacs of Holland.

ALCHIMILLA, or ALCHEMILLA, *la-*

dies' mantle, in botany, a genus of the Tetrandria Monogynia class of plants, the calyx of which is a single-leafed perianthium; there is no corolla, nor any pericarpium: the cup finally becomes a capsule, containing a single elliptical and compressed seed. There are four species, A. vulgaris, common ladies' mantle, or beanfoot, is frequent in meadows and pastures in England. It is perennial, and flowers in June and July. Horses, sheep, and goats, eat it. The great richness of the milk in the celebrated dairies of the Alps is attributed to the plenty of this plant, and that of the rib-wort plantain. The plant is astringent, and in Gothland and other places a tincture of its leaves is given in spasmodic and convulsive cases. A. alpina, cinquefoil, or alpine ladies' mantle, grows naturally in the North of England, North Wales, and in the Highlands of Scotland. It is a native of the northern parts of Europe, and is admitted into the gardens on account of its elegance. The A. pentaphyllea grows naturally on the Alps, and is found in the botanical gardens in this country: it may be propagated by parting the roots in autumn. They should have a moist soil, and a shady situation.

ALCHORNEA, in botany, a genus of the Monadelphia Octandria class and order, of which there is but a single species. Male, calyx three, five-leaved; corolla none: female, calyx five-toothed; corolla none; styles two-parted.

ALCOHOL, a term applied by chemists to the purely spirituous part of liquors that have undergone the vinous fermentation. It is in all cases the product of the saccharine principle, and is formed by the successive processes of vinous fermentation and distillation. Various kinds of ardent spirits are known in commerce, as brandy, rum, &c.; but they differ in colour, taste, smell, &c. The spirituous part, however, is the same in each, and may be procured in its purest state by a second distillation, which is termed rectification. See DISTILLATION, FERMENTATION, and RECTIFICATION. Alcohol is procured most largely in this country from a fermented grain-liquor; but in France and other wine countries, the spirit is obtained from the distillation of wine, hence the term spirit of wine. See BRANDY. Alcohol is a colourless, transparent liquor, appearing to the eye like pure water. It possesses a peculiar penetrating smell, distinct from the proper odour of the distilled spirit from which it is procured. To the taste it is excessively hot and burning; but without any peculiar flavour. From its lightness, the bubbles which are formed by shaking subside almost instantaneously, which is one method of judging of its purity. Alcohol may be volatilized by the heat of the hand. It is converted into vapour at the temperature of 55° of Fahrenheit, and it boils at 165°. It has never been frozen by any degree of cold, natural or artificial, and on this account it has been much used in the construction of thermometers. Alcohol mixes with water in all proportions, and during the mixture heat is extricated, which is sensible to the hand. At the same time there is a mutual penetration of the parts, so that the bulk of the two liquors when mixed is less than when separate; consequently the specific gravity of the mixture is greater than the mean specific gravity of the two liquors taken apart. Alcohol is supposed to consist of

Carbon	28.53
Hydrogen . . .	7.87
Water	63.6
	100.00

Its uses are many and important: it is employed as a solvent for those resinous gums which form the basis of numerous varnishes: it is employed also as the basis of artificial cordials and liquors, to which a flavour and additional taste are given by particular admixtures: it serves as a solvent for the more active parts of vegetables, under the form of tinctures. The antiseptic power of alcohol renders it particularly valuable in preserving particular parts of the body as anatomical preparations. The steady and uniform heat which it gives during the combustion makes it a valuable material for burning in lamps.

ALCORAN, or ALKORAN, the name of a book held equally sacred among the Mahometans as the bible is among Christians.

The word *alcoran* properly signifies reading; a title given it by way of eminence, just as we call the Old and New Testament *Scriptures*.

That Mahomet was the author of the Alcoran is allowed both by Christians and the Mahometans themselves; only the latter are fully persuaded, that it was revealed to him by the ministry of the angel Gabriel; whereas the former, with more reason, think it all his own invention, assisted by one Sergius, a Christian monk. The Alcoran is held not only of divine original, but eternal and uncreated, remaining, as some express it, in the very essence of God. The first transcript has been from everlasting by God's throne,

written on a table of vast bigness, in which are also recorded the divine decrees, past and future. A copy from this table, in one volume, on paper, was sent down to the lowest heaven, in the month of Ramadan, on the night of power. From whence it was delivered out to Mahomet by parcels, some at Mecca, and some at Medina. Though he had the consolation of seeing the whole once a year, and in the last part of his life twice. Ten new chapters were delivered entire, the greater part only in separate periods, which were written down from time to time by the prophet's amanuensis, in this or that part of this or the other chapter, as he directed. The first parcel that was revealed was the five first verses of the ninety-sixth chapter, which the prophet received in a cave of Mount Harah, near Mecca.

The general aim of the Alcoran was, to unite the professors of the three different religions then followed in Arabia, Idolaters, Jews, and Christians, in the knowledge and worship of one God, under the sanction of certain laws, and the outward signs of ceremonies, partly of ancient, and partly of novel institution, enforced by the consideration of rewards and punishments both temporal and eternal, and to bring all to the obedience of Mahomet, as the prophet and ambassador of God, who was to establish the true religion on earth, and be acknowledged chief pontiff in spiritual matters. The chief point therefore inculcated in the Alcoran is the unity of God, to restore which, the prophet confessed, was the chief end of his mission. The rest is taken up in prescribing necessary laws and directions, frequent admonitions to moral and divine virtues, the worship and reverence of the Supreme Being, and resignation to his will.

As to the book itself, as it now stands, it is divided into 114 Suras, or chapters, which are again divided into smaller portions or verses. But, besides these divisions, Mahometan writers farther divide it into 60 equal portions, called *hiz*, or *hazah;* each of which they subdivide into four parts.

After the title at the head of each chapter, except the ninth, is prefixed the formula, "In the name of the most merciful God," called by the Mahometans Bismallah, wherewith they constantly begin all their books and writings, as the distinguishing mark of their religion.

Twenty-nine of the chapters of the Alcoran have this further peculiarity, that there are certain letters of the alphabet prefixed to them. In some a single letter, in others two or more. These letters are supposed, by the true believers, to conceal divers profound mysteries, the understanding whereof has been communicated to no man, their prophet excepted. Yet some have pretended to find their meaning, by supposing the letters to stand for so many words, expressing the names, attributes, and works of God; others explain these letters from the organ made use of in their pronunciation; others from their value in numbers.

There are seven principal editions of the Koran, two at Medina, one at Mecca, one at Cufa, one at Bassora, one in Syria, and the common or vulgate edition. The first contains 6000 verses; the second and fifth, 6214; the third, 6219; the fourth, 6236; the sixth, 6226; and the last, 6225; but the number of words and letters is the same in all, viz. 77,639 words, and 323,015 letters.

The Alcoran is allowed to be written with the utmost elegance and purity of language, in the dialect of the Koreishites, the most noble and polite of all the Arabians, but with some mixture of other dialects. It is the standard of the Arabic tongue, and as the orthodox believed, and are taught by the book itself, inimitable by any human pen; and therefore insisted on as a permanent miracle, greater than that of raising the dead, and alone sufficient to convince the world of its divine original; and to this miracle did Mahomet himself chiefly appeal, for the confirmation of his mission, publicly challenging the most eloquent schoolmen in Arabia to produce a single chapter comparable to it. A late ingenious and candid writer, who is a very good judge, allows the style of the Alcoran to be generally beautiful and fluent, especially where it imitates the prophetic manner and scripture phrase; concise, and often obscure; adorned with bold figures, after the eastern taste; enlivened with florid and sententious expressions; and, in many places, especially where the majesty and attributes of God are described, sublime and magnificent.

To the pomp and harmony of expression some ascribe all the force and effect of the Alcoran; which they consider as a sort of music, equally fitted to ravish and amaze, with other species of that art. In this Mahomet succeeded so well, and so strangely captivated the minds of his audience, that several of his opponents thought it the effect of witchcraft and enchantment, as he himself complains.

So numerous are the commentaries on

the Alcoran, that a catalogue of their bare titles would make a volume; we have a very elegant translation of it into English by Mr. Sale; who has added a preliminary discourse, with other occasional notes, which the curious may consult on this head.

Among Mahometans this book is held in the greatest reverence and esteem. The Mussulmen dare not touch it without being first washed, or legally purified; to prevent which, an inscription is put on the cover or label: "Let none touch it but they who are clean." It is read with great care and respect. They swear by it, take omens from it on all weighty occasions, carry it with them to war, write sentences of it on their banners, adorn it with gold and precious stones, and do not suffer it to be in the possession of any who hold a different religion.

ALCYON, in natural history, a name given to the kingsfisher. See ALCEDO.

ALCYONIUM, in natural history, a genus of Zoophytes, the characters of which are, that the animal grows in the form of a plant; the stem or root is fixed, fleshy, gelatinous, spongy, or coriaceous, with a cellular epidermis, penetrated with stellated pores, and shooting out tentaculated oviparous hydræ. There are 28 species. From some experiments made by Mr. Hatchett, and related by him in the Phil. Trans. on several of the species of alcyonium, he was led to conclude, that they were all composed of a soft, flexible, membranaceous substance, slightly hardened by carbonate, mixed with a small portion of phosphate of lime.

ALDEBARAN, in astronomy, a star of the first magnitude, called in English the Bull's eye, as making the eye of the constellation Taurus.

ALDER-*tree*, the English name of a genus of trees, called by botanists alnus. See ALNUS.

ALDERMAN, in the British policy, a magistrate subordinate to the mayor of a city or town corporate.

The number of these magistrates is not limited, but is more or less, according to the magnitude of the place. In London they are twenty-six; each having one of the wards of the city committed to his care. Their office is for life; so that when one of them dies, or resigns, a wardmote is called, who return two persons, one of whom the lord mayor and aldermen choose, to supply the vacancy.

ALDROVANDA, in botany, a genus of the Pentandria Pentaginia class and order, of which there is only one species, viz. the A. vesiculosa, found in marshes in Italy and India, with bladders like utricularia, but in bunches.

ALE-*conner*, an officer in London, who inspects the measures of public houses. They are four in number, and chosen by the common-hall of the city

ALE-*houses*, no licence to be granted to any person, unless he produce a certificate of his good character, under the hands of the clergyman, churchwardens, &c. Penalties for selling without a licence, unless at fairs, 40*s*. for the first offence, 5*l*. for the second; no person can sell wine to be drank at his own house, who has not an ale licence.

ALE-*silver*, a tax paid yearly to the lord mayor of London, by all who sell ale within the city.

ALECTRA, in botany, a genus of the Didynamia Angiosperma class and order, of which there is a single species only, viz. A. capensis, a native of the Cape of Good Hope; found in grassy places near rivers; flowering in November and December.

ALEMBERT (JOHN LE ROND D') an eminent French mathematician and philosopher, and one of the brightest ornaments of the 18th century. He was perpetual secretary to the French Academy of Sciences, and a member of most of the philosophical academies and societies of Europe.

D'Alembert was born at Paris, the 16th of November, 1717, and derived the name of John le Rond, from that of the church, near which, after his birth, he was exposed as a foundling. But his father, Destouches Canon, informed of this circumstance, listening to the voice of nature and duty, took measures for the proper education of his child, and for his future subsistence in a state of ease and independence. His mother, it is said, was a lady of rank, the celebrated Mademoiselle Tencin, sister to cardinal Tencin, archbishop of Lyons.

He received his first education among the Jansenists, in the College of the Four Nations, where he gave early signs of genius and capacity. In the first year of his philosophical studies, he composed a Commentary on the Epistle of St. Paul to the Romans. The Jansenists considered this production as an omen, that portended to the party of Port-Royal a restoration to some part of their former splendour, and hoped to find one day, in D'Alembert, a second Pascal. To render the resemblance more complete, they engaged their pupil in the study of the ma-

thematics; but they soon perceived that his growing attachment to this science was likely to disappoint the hopes they had formed with respect to his future destination; they therefore endeavoured to divert him from the pursuit; but their endeavours were fruitless.

On his quitting the college, finding himself alone, and unconnected in the world, he sought an asylum in the house of his nurse, who was the wife of a glazier. He hoped that his fortune, though not ample, would enlarge the subsistence, and better the condition of her family, which was the only one that he could consider as his own. It was here, therefore, that he fixed his residence, resolving to apply himself entirely to the study of geometry. And here he lived, during the space of 30 years, with the greatest simplicity, discovering the augmentation of his means only by increasing displays of his beneficence, concealing his growing reputation and celebrity from these honest people, and making their plain and uncouth manners the subject of good-natured pleasantry and philosophical observation. His good nurse perceived his ardent activity; heard him mentioned as the writer of many books; and beheld him with a kind of compassion: "You will never," said she to him one day, "be any thing but a philosopher—and what is a philosopher?—a fool, who toils and plagues himself all his life, that people may talk of him when he is dead."

As D'Alembert's fortune did not far exceed the demands of necessity, his friends advised him to think of some profession that might enable him to increase it. He accordingly turned his views to the law, and took his degrees in that faculty, which he soon after abandoned, and applied himself to the study of medicine. Geometry, however, was always drawing him back to his former pursuits: so that, after many ineffectual struggles to resist its attractions, he renounced all views of a lucrative profession, and gave himself up entirely to mathematics and poverty. In the year 1741 he was admitted a member of the Academy of Sciences; for which distinguished literary promotion, at so early an age (24,) he had prepared the way, by correcting the errors of the "Analyse Demontrée" of Reyneau, which was highly esteemed in France in the line of analytics. He afterwards set himself to examine, with attention and assiduity, what must be the motion and path of a body, which passes from one fluid into another denser fluid, in a direction oblique to the surface between the two fluids. Two years after his election to a place in the academy, he published his "Treatise on Dynamics." The new principle developed in this treatise consisted in establishing an equality, at each instant, between the changes that the motion of a body has undergone, and the forces or powers which have been employed to produce them; or, to express the same thing otherwise, in separating into two parts the action of the moving powers, and considering the one as producing alone the motion of the body in the second instant, and the other as employed to destroy that which it had in the first.

So early as the year 1744, D'Alembert had applied this principle to the theory of the equilibrium, and the motion of fluids; and all the problems before resolved in physics became in some measure its corollaries. The discovery of this new principle was followed by that of a new calculus, the first essays of which were published in a "Discourse on the General Theory of the Winds:" to this the prize-medal was adjudged by the Academy of Berlin, in the year 1746, which proved a new and brilliant addition to the fame of D'Alembert. This new calculus of "Partial Differences" he applied, the year following, to the problem of vibrating chords, the resolution of which, as well as the theory of the oscillations of the air, and the propagation of sound, had been but imperfectly given by the mathematicians who preceded him; and these were his masters or his rivals. In the year 1749 he furnished a method of applying his principle to the motion of any body of a given figure. He also resolved the problem of the precession of the equinoxes: determining its quantity, and explaining the phenomenon of the nutation of the terrestrial axis discovered by Dr. Bradley.

In 1752, D'Alembert published a treatise on the "Resistance of Fluids," to which he gave the modest title of an "Essay," though it contains a multitude of original ideas and new observations. About the same time he published, in the Memoirs of the Academy of Berlin, "Researches concerning the Integral Calculus," which is greatly indebted to him for the rapid progress it has made in the present century.

While the studies of D'Alembert were confined to mere mathematics, he was little known or celebrated in his native country. His connections were limited to a small

society of select friends. But his cheerful conversation, his smart and lively sallies, a happy method at telling a story, a singular mixture of malice of speech with goodness of heart, and of delicacy of wit with simplicity of manners, rendering him a pleasing and interesting companion, his company began to be much sought after in the fashionable circles. His reputation at length made its way to the throne, and rendered him the object of royal attention and beneficence. The consequence was, a pension from government, which he owed to the friendship of count D'Argenson.

But the tranquillity of D'Alembert was abated when his fame grew more extensive, and when it was known, beyond the circle of his friends, that a fine and enlightened taste for literature and philosophy accompanied his mathematical genius. Our author's eulogist ascribes to envy, detraction, &c. all the opposition and censure that D'Alembert met with on account of the famous Encyclopédie, or Dictionary of Arts and Sciences, in conjunction with Diderot. None surely will refuse the well deserved tribute of applause to the eminent displays of genius, judgment, and true literary taste, with which D'Alembert has enriched that great work. Among others, the Preliminary Discourse he has prefixed to it, concerning the rise, progress, connections, and affinities, of all the branches of human knowledge, is perhaps one of the most capital productions the philosophy of the age can boast of.

Some time after this, D'Alembert published his "Philosophical, Historical, and Philological Miscellanies." These were followed by the "Memoirs of Christiana, Queen of Sweden;" in which D'Alembert shewed that he was acquainted with the natural rights of mankind, and was bold enough to assert them. His "Essay on the Intercourse of Men of Letters with Persons high in Rank and Office" wounded the former to the quick, as it exposed to the eyes of the public the ignominy of those servile chains which they feared to shake off, or were proud to wear. A lady of the court, hearing one day the author accused of having exaggerated the despotism of the great, and the submission they require, answered slyly, "If he had consulted me, I would have told him still more of the matter."

D'Alembert gave elegant specimens of his literary abilities in his translations of some select pieces of Tacitus. But these occupations did not divert him from his mathematical studies; for about the same time he enriched the Encyclopédie with a multitude of excellent articles in that line, and composed his "Researches on several Important Points of the System of the World," in which he carried to a higher degree of perfection the solution of the problem concerning the perturbations of the planets, that had several years before been presented to the Academy. In 1759 he published his "Elements of Philosophy;" a work much extolled, as remarkable for its precision and perspicuity. The resentment that was kindled (and the disputes that followed it) by the article Geneva, inserted in the Encyclopédie, are well known. D'Alembert did not leave this field of controversy with flying colours. Voltaire was an auxiliary in the contest; but as he had no reputation to lose, in point of candour and decency, and as he weakened the blows of his enemies by throwing both them and the spectators into fits of laughter, the issue of the war gave him little uneasiness. It fell more heavily on D'Alembert; and exposed him, even at home, to much contradiction and opposition. It was on this occasion that the late King of Prussia offered him an honourable asylum at his court, and the office of president of his academy: and the king was not offended at D'Alembert's refusal of these distinctions, but cultivated an intimate friendship with him during the rest of his life. He had refused, some time before this, a proposal made by the Empress of Russia, to entrust him with the education of the Grand Duke;—a proposal accompanied with all the flattering offers that could tempt a man, ambitious of titles, or desirous of making an ample fortune; but the objects of his ambition were tranquillity and study. In the year 1765, he published his "Dissertation on the Destruction of the Jesuits." This piece drew upon him a swarm of adversaries, who only confirmed the merit and crdit of his work by their manner of attacking it.

Beside the works already mentioned, he published nine volumes of memoirs and treatises, under the title of "Opuscules;" in which he has resolved a multitude of problems relating to astronomy, mathematics, and natural philosophy; of which his panegyrist, Condorcet, gives a particular account, more especially of those which exhibit new subjects, or new methods of investigation. He published also "Elements of Music;" and rendered, at length, the system of Rameau intelligible; but he did not think the mathe-

matical theory of the sonorous body sufficient to account for the rules of that art. In the year 1772 he was chosen Secretary to the French Academy of Sciences. He formed, soon after this preferment, the design of writing the lives of all the deceased academicians, from 1700 to 1772; and in the space of three years he executed this design, by composing seventy eulogies.

The correspondence which D'Alembert held with eminent literary characters, and his constant intercourse with learned men of all nations, together with his great influence in the academy, concurred to give him a distinguished importance above most of his countrymen. By some, who were jealous of his reputation, he was denominated the Mazarin of literature; but there seems now no doubt, but that his influence was obtained by his great talents and learning, rather than by artful management and supple address. He was a decided and open enemy to superstition and priestcraft. Without inquiring into the merits of Christianity, he concluded, that the religion taught in France was that which believers in general regarded as the true doctrine, and which he rejected as a fable unworthy the attention of the philosopher. There is no reason to think that he ever studied the foundations on which natural and revealed religion were built; and it is certain that he adopted a system of deified nature, which bereaves the world of a designing cause and presiding intelligence. He was zealous even in propagating the opinions which he adopted, and might be regarded as an apostle of atheism. The eccentricity of his opinions did not destroy the moral virtues of his heart. A love of truth, and a zeal for the progress of real science and liberty, formed the basis of his character: strict probity, a noble disinterestedness, and an habitual desire of being useful, were its distinguishing features. To the young, who possessed talents and genius, he was a patron and instructor: to the poor and oppressed he became a firm and generous friend: to those who had shown him kindness, he never ceased to be grateful; a sure evidence of a great mind. To two ministers who had befriended him in their prosperity, he dedicated works when they were in disgrace with the court. An instance of a kind, a grateful disposition, was displayed by D'Alembert in early life. His mother, who had infamously disowned and abandoned him, hearing of the greatness of his talents, and of the promise which he gave of future celebrity, obtained an interview, and laid claim to the character of a parent.—"What do I hear," said the indignant youth, "you are the mother-in-law, the glazier's wife is my true mother:" for her, indeed he never ceased to testify the affection and gratitude of a child: and under her roof he resided, as we have seen, many years, till an alarming illness made it necessary for him to remove to a more airy lodging. D'Alembert maintained his high rank and reputation among mathematicians and philosophers till his death, in October 1783. His loss was deplored by survivors of every country; but his particular friends and associates exhibited, on the occasion, every mark of grief, which real and unaffected sorrow can alone supply for undissembled worth.

ALEMBIC, in chemistry, a vessel usually made of glass or copper, formerly used for distillation. The bottom, in which the substance to be distilled is put, is called the *cucurbit;* the upper part is called the head, the beak of which is fitted into the neck of the receiver. Retorts and the common worm-still are now more generally employed. See CHEMISTRY, DISTILLATION, &c.

ALETRIS, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Liliæ or Liliaceæ, of which there are nine species; A. farinosa, or American aletris, used by the natives in coughs, and in the pleurisy. Some of the species are natives of the Cape of Good Hope, others are found natural in Ceylon and Guinea. The A. zelanica, or Ceylon aloe, is common in gardens where exotic plants are preserved. A. guianensis, or Guinea aloe, when in flower, seldom continues in beauty more than two or three days, and never produces seeds in England. The Ceylon, Guinea, and sweet-scented species, are too tender to live through the winter in England, unless in a warm stove; and they will not produce flowers if the plants are not plunged into a tan-bed. The creeping roots of the Ceylon and Guinea sorts send up many heads, which should be cut off in June, and after having been laid in the stove a fortnight, that the wounded part may heal, they should be planted in small pots of light sandy earth, plunged into a moderate hot bed, and treated like other tender succulent plants, and be never set abroad in summer.

ALEURITES, in botany, a genus of the Monœcia Monadelphia class and order, of the natural order of Tricoccæ. The flowers are male and female; the calyx

of the male is a perianthium; the corollas five petals; the nectary has five-cornered scales; the stamens are numerous filaments; the anthers roundish. The female flowers are few, the calyx, corolla, and nectarium, as in the male, but larger. There are two seeds with a double bark. Only one species, a tree in the islands of the South Seas.

ALEXANDRIAN *Copy of the New Testament*, preserved in the British Museum, is referred to as an object of curiosity, as well as of considerable importance, to persons who study the scriptures critically. It consists of four large quarto, or rather folio volumes, containing the whole bible in Greek, including the Old and New Testament, with the Apocrypha, and some smaller pieces, but not quite complete. It was placed in the British Museum in 1758; and had been a present to Charles I. from Cyrillus Lucaris, a native of Crete, and patriarch of Constantinople, by sir Thomas Rowe, ambassador from England to the Grand Seignior in the year 1628. Cyrillus brought it with him from Alexandria, where it was probably written. It is said to have been written by Thecla, a noble Egyptian lady, about thirteen hundred years ago. In the New Testament there is wanting the beginning, as far as Matt. xxv. 6; likewise from John vi. 50, to viii. 52; and from 2 Cor. iv. 19, to xii. 7. It has neither accents nor marks of aspiration it is written with capital, or, as they are called, *uncial* letters, and there are no intervals between the words, but the sense of a passage is sometimes terminated by a point, and sometimes by a vacant space. Dr. Woide published this valuable work in 1786, with types cast for the purpose, line for line, precisely like the original MS: the copy has been examined with the greatest care, and it is found to be so perfect a resemblance of the original, that it may supply its place. The authenticity, antiquity, &c. of this MS. is briefly, but ably, discussed in Rees's New Cyclopedia, Vol I. p. ii.

ALGÆ, in botany, an order or division of the Cryptogamia class of plants. It is one of the seven families or natural tribes into which the vegetable kingdom is distributed, in the Philosophia Botanica of Linnæus; the 57th order of his fragments of a natural method.

The plants belonging to this order are described as having their root, leaf, and stem, entire, or all one. The whole of the sea-weeds, and various other aquatic plants, are comprehended under this division. From their admitting of little distinction of root, leaf, or stem, and the parts of their flowers being equally incapable of description; the genera are distinguished by the situation of what is supposed to be flowers or seeds, or by the resemblance which the whole plant bears to some other substance. The parts of fructification are either found in saucers and tubercles, as in lichens; in hollow bladders, as in the fuci; or dispersed through the whole substance of the plants, as in the ulvæ. The substance of the plants has much variety; it is flesh-like or leather-like, membranaceous or fibrous, jelly-like or horn-like, or it has the resemblance of a calcareous earthy matter.

Lamarck distributes the algæ into three sections: the first comprehends all those plants, whose fructification is not apparent, or seems doubtful. These commonly live in water, or upon moist bodies, and are membranous, gelatinous, or filamentous. To this section he refers the byssi, conferva, ulva, tremella, and varec. The plants of the second section are distinguished by their apparent fructification, though it be little known, and they are formed of parts which have no particular and sensible opening or explosion, at any determined period; their substance is ordinarily crustaceous or coriaceous. They include the tassella, ceratosperma, and lichen. The third section comprehends plants which have their fructification very apparent, and distinguished by constituent parts, which open at a certain period of maturity, for the escape of the fecundating dust or seeds. These plants are more herbaceous, as to both their substance and their colour, than those of the other two sections, and are more nearly related to the mosses, from which they do not essentially differ. Their flowers are often contained in articulated and very elastic filaments. To this section are referred the riccia, blasia, anthoceros, targiona, hepatica, and junger-manna. In the Linnæan system the algæ are divided into two classes, viz. the terrestres and aquaticæ. The former include the anthoceros, blacia, riccia, lichen, and byssus; and the latter are the ulva fucus, and conferva. The fructification of the algæ, and particularly of those called aquaticæ, is denominated, by a judicious botanist, the opprobrium botanicorum.

ALGAROTH. See Antimony.

ALGEBRA, a general method of resolving mathematical problems by means of equations; or, it is a method of computation by symbols, which have been

invented for expressing the quantities that are the objects of this science, and also their mutual relation and dependence. These quantities might, probably, in the infancy of the science, be denoted by their names at full length; these, being found inconvenient, were succeeded by abbreviations, or by their mere initials; and, at length, certain letters of the alphabet were adopted as general representations of all quantities; other symbols or signs were introduced, to prevent circumlocution, and to facilitate the comparison of various quantities with one another; and, in consequence of the use of letters or species, and other general symbols, or indeterminate quantities, algebra obtained the appellation of specious, literal, and universal arithmetic. The origin of Algebra, like that of other sciences of ancient date and gradual progress, is not easily ascertained. The most ancient treatise on that part of analytics, which is properly called algebra, now extant, is that of Diophantus, a Greek author of Alexandria, who flourished about the year of our Lord 350, and who wrote 13 books, though only six of them are preserved, which were printed, together with a single imperfect book on multangular numbers, in a Latin translation by Xylander, in 1575, and afterwards in Greek and Latin, with a comment, in 1621 and 1670, by Gaspar Bachet, and M. Fermat, Tolosæ, fol. These books do not contain a treatise on the elementary parts of algebra, but merely collections of some difficult questions relating to square and cube numbers, and other curious properties of numbers, with their solutions. Algebra, however, seems not to have been wholly unknown to the ancient mathematicians, long before the age of Diophantus. We observe the traces and effects of it in many places, though it seems as if they had intentionally concealed it. Something of it appears in Euclid, or at least in Theon upon Euclid, who observes that Plato had begun to teach it. And there are other instances of it in Pappus, and more in Archimedes and Appollonius. But it should be observed, that the analysis used by these authors is rather geometrical than algebraical; this appears from the examples that occur in their works; and, therefore, Diophantus is the first and only author among the Greeks who has treated professedly of algebra. Our knowledge of the science was derived, not from Diophantus, but from the Moors or Arabians; but whether the Greeks or Arabians were the inventors of it has been a subject of dispute. It is probable, however, that it is much more ancient than Diophantus, because his treatise seems to refer to works similar and prior to his own.

Algebra is a peculiar kind of arithmetic, which takes the quantity sought, whether it be a number, or a line, or any other quantity, as if it were granted; and by means of one or more quantities given, proceeds by a train of deductions, till the quantity at first only supposed to be known, or at least some power of it, is found to be equal to some quantity or quantities which are known, and consequently itself is known.

Algebra is of two kinds, numeral and literal.

ALGEBRA, *numeral* or *vulgar*, is that which is chiefly concerned in the resolution of arithmetical questions. In this, the quantity sought is represented by some letter or character; but all the given quantities are expressed by numbers. Such is the algebra of the more ancient authors, as Diophantus, Paciolus, Stifelius, &c. This is thought by some to have been an introduction to the art of keeping merchants' accounts by double entry.

ALGEBRA, *specious* or *literal*, or the new algebra, is that in which all the quantities, known and unknown, are expressed or represented by their species, or letters of the alphabet. There are instances of this method from Cardan, and others about his time; but it was more generally introduced and used by Vieta. Dr. Wallis apprehends that the name of specious arithmetic, applied to algebra, is given to it with a reference to the sense in which the Civilians use the word species. Thus, they use the names Titus, Sempronius, Caius, and the like, to represent indefinitely any person in such circumstances; and cases so propounded, they call species. Vieta, accustomed to the language of the civil law, gave, as Wallis supposes, the name of species to the letters, A, B, C, &c. which he used to represent indefinitely any number or quantity so circumstanced, as the occasion required. This mode of expression frees the memory and imagination from that stress or effort, which is required to keep several matters, necessary for the discovery of the truth investigated, present to the mind; for which reason this art may be properly denominated metaphysical geometry. Specious algebra is not, like the numeral, confined to certain kinds of

problems; but serves universally for the investigation or invention of theorems, as well as the solution and demonstration of all kinds of problems, both arithmetical and geometrical. The letters used in algebra do each of them, separately, represent either lines or numbers, as the problem is either arithmetical or geometrical; and, together, they represent planes, solids, and powers, more or less high, as the letters are in a greater or less number. For instance, if there be two letters, a b, they represent a rectangle, whose two sides are expressed, one by the letter a, and the other by b; so that by their mutual multiplication they produce the plane $a\,b$. Where the same letter is repeated twice, as $a\,a$, they denote a square. Three letters, $a\,b\,c$, represent a solid, or a rectangular parallelopiped, whose three dimensions are expressed by the three letters $a\,b\,c$; the length by a, the breadth by b, and the depth by c; so that by their mutual multiplication they produce the solid $a\,b\,c$. As the multiplication of dimensions is expressed by the multiplication of letters, and as the number of these may be so great as to become incommodious, the method is only to write down the root, and on the right hand to write the index of the power, that is, the number of letters of which the quantity to be expressed consists; as a^2, a^3, a^4, &c. the last of which signifies as much as a multiplied four times into itself; and so of the rest. But as it is necessary, before any progress can be made in the science of algebra, to understand the method of notation, we shall here give a general view of it. In algebra, as we have already stated, every quantity, whether it be known or given, or unknown or required, is usually represented by some letter of the alphabet; and the given quantities are commonly denoted by the initial letters, a, b, c, d, &c. and the unknown ones by the final letters, u, w, x, y, z. These quantities are connected together by certain signs or symbols, which serve to shew their mutual relation, and at the same time to simplify the science, and to reduce its operations into a less compass. Accordingly the sign $+$, plus, or more, signifies that the quantity to which it is prefixed is to be added, and it is called a positive or affirmative quantity. Thus, $a+b$, expresses the sum of the two quantities a and b, so that if a were 5, and b 3, $a+b$ would be $5+3$, or 8. If a quantity have no sign, $+$, plus, is understood, and the quantity is affirmative or positive. The sign $-$, minus, or less, denotes that the quantity which it precedes is to be subtracted, and it is called a negative quantity. Thus $a-b$ expresses the difference of a and b; so that a being 5, and b 3, $a-b$, or $5-3$, would be equal to 2. If more quantities than two were connected by these signs, the sum of those with the sign $-$ must be subtracted from the sum of those with the sign $+$. Thus $a+b-c-d$ represents the quantity which would remain, when c and d are taken from a and b. So that if a were 7, b 6, c 5, and d 3, $a+b-c-d$, or $7+6-5-3$, or $13-8$, would be equal to 5. If two quantities are connected by the sign $\backsim$, as $a \backsim b$, this mode of expression represents the difference of a and b, when it is not known which of them is the greatest. The sign $\times$ signifies that the quantities between which it stands are to be multiplied together, or it represents their product. Thus, $a \times b$ expresses the product of a and b; $a \times b \times c$ denotes the product of a, b, and c; $(a+b) \times c$ denotes the product of the compound quantity $a+b$ by the simple quantity c; and $(a+b+c) \times (a-b+c) \times (a+b)$ represents the product of the three compound quantities, multiplied continually into one another; so that if a were 5, b 4, and c 3, then would $(a+b+c) \times (a-b+c) \times (a+c)$ be $12 \times 4 \times 8$, or 384. The parenthesis used in the foregoing expressions indicate that the whole compound quantities are affected by the sign, and not simply the single terms between which it is placed. Quantities that are joined together without any intermediote sign form a product; thus $a\,b$ is the same with $a \times b$, and $a\,b\,c$ the same with $a \times b \times c$. When a quantity is multiplied into itself, or raised to any power, the usual mode of expression is to draw a line over the quantity, and to place the number denoting the power at the end of it, which number is called the index or exponent. Thus, $(a+b)^2$ denotes the same as $(a+b) \times (a+b)$ or second power, or square, of $a+b$ considered as one quantity; and $(a+b)^3$ denotes the same as $(a+b) \times (a+b) \times (a+b)$, or the third power, or cube, of $a+b$. In expressing the powers of quantities represented by single letters, the line over the top is usually omitted: thus, a^2 is the same as $a\,a$ or $a \times a$, and b^3 the same as $b\,b\,b$ or $b \times b \times b$, and $a^2\,b^3$, the same as $a\,a \times b\,b\,b$ or $a \times a \times b \times b \times b$. The full point . and the word into, are sometimes used instead of $\times$ as the sign of multiplication. Thus, $(a+b)\,.\,(a+c)$,

and $a+b$ into $a+c$, signify the same thing as $(a+b)\times(a+c)$, or the product of $a+b$ by $a+c$. The sign $\div$ is the sign of division, as it denotes that the quantity preceding it is to be divided by the succeeding quantity. Thus, $c\div b$ signifies that c is to be divided by b; and $(a+b)\div(a+c)$, that $a+b$ is to be divided by $a+c$. The mark) is sometimes used as a note of division; thus $a+b)\,a\,b$ denotes that $a\,b$ is to be divided by $a+b$. But the division of algebraic quantities is most commonly expressed by placing the divisor under the dividend, with a line between them, like a vulgar fraction. Thus, $\frac{c}{b}$ represents the quantity arising by dividing c by b, or the quotient, and $\frac{a+b}{a+c}$ represents the quotient of $a+b$ divided by $a+c$. Quantities thus expressed are called algebraic fractions.

The sign $\surd$ expresses the square root of any quantity to which it is prefixed; thus $\surd\,25$ signifies the square root of 25, or 5, because 5×5 is 25; and $\surd\,(a\,b)$ denotes the square root of $a\,b$; and $\surd\left(\frac{a\,b+b\,c}{d}\right)$ denotes thesquare root of $\frac{ab+bc}{d}$, or of the quantity arising from the division of $a\,b+b\,c$ by d; but $\frac{\surd(a\,b+b\,c)}{d}$, which has the separating line drawn under $\surd$, signifies that the square root of $a\,b+b\,c$ is to be first taken, and afterwards divided by d; so that if a were 2, b 6, c 4, and d 9, $\frac{\surd(a\,b+b\,c)}{d}$ would be $\frac{\surd 36}{9}$ or $\frac{6}{9}$; but $\surd\left(\frac{a\,b+b\,c}{d}\right)$ would be $\surd\left(\frac{36}{9}\right)$ or $\surd\,4$, which is 2. The sign $\surd$ with a figure over it is used to express the cubic or biquadratic root, &c. of any quantity; thus $\sqrt[3]{}\,64$ represents the cube root of 64, or 4, because $4\times4\times4$ is 64; and $\sqrt[3]{}\,(a\,b+c\,d)$ the cube root of $a\,b+c\,d$. In like manner $\sqrt[4]{16}$ denotes the biquadratic root of 16, or 2, because $2\times2\times2\times2$ is 16, and $\sqrt[4]{}\,(a\,b+c\,d)$ denotes the biquadratic root of $a\,b+c\,d$; and so of others. Quantities thus expressed are called radical quantities, or surds; of which those, consisting of one term only, as $\surd\,a$ and $\surd\,(a\,b$, are called simple surds; and those consisting of several terms or numbers, as $\surd\,(a^2-b^2)$ and $\sqrt[3]{}\,(a^3-b+b\,c)$ are denominated compound surds. Another commodious method of expressing radical quantities is that which denotes the root by a vulgar fraction, placed at the end of a line drawn over the quantity given. In this notation, the square root is expressed by $\frac{1}{2}$, the cube root by $\frac{1}{3}$, the biquadratic root by $\frac{1}{4}$, &c. Thus $a\,\frac{1}{2}$ expresses the same quantity with $\surd\,a$, i. e. the square root of a, and $(a^2+a\,b)\,\frac{1}{3}$ the same as $\sqrt[3]{}\,(a^2+a\,b)$, i. e. the cube root of $a^2+a\,b$; and $\overline{a}|\frac{2}{3}$ denotes the cube root of the square of a, or the square of the cube root of a; and $(a+z)\frac{7}{4}$ the seventh power of the biquadratic root of $a+z$; and so of others; $(a^2)\,\frac{1}{2}$ is a, $\overline{a^3}|\frac{1}{3}$ is a, &c. Quantities that have no radical sign ($\surd$) or index annexed to them, are called rational quantities. The sign $=$, called the sign of equality, signifies that the quantities between which it occurs are equal. Thus $2+3=5$, shews that 2 plus 3 is equal to 5; and $x=a-b$ shews that x is equal to the difference of a and b. The mark : : signifies that the quantities between which it stands are proportional. As $a:b::c:d$ denotes that a is in the same proportion to b as c is to d; or that if a be twice, thrice, or four times, &c. as great as b, c will be twice, thrice, or four times, &c. as great as d. When anyquantityistobetakenmorethan once, the number, which shows how many times it is to be taken, must be prefixed; thus $5\,a$ denotes that the quantity a is to be taken 5 times, and $3\,b\,c$ represents three times $b\,c$, and $7\,\surd\,(a^2\times b^2)$ denotes that $\surd\,(a^2+b^2)$ is to be taken 7 times, &c. The numbers thus prefixed are called co-efficients; and if a quantity have no co-efficient, unit is understood, and it is to be taken only once. Similar or like quantities are those that are expressed by the same letters under the same powers, or which differ only in their co-efficients; thus, $3\,b\,c$, $5\,b\,c$, and $8\,b\,c$, are like quantities, and so are the radicals $2\,\surd\left(\frac{b+c}{a}\right)$ and $7\,\surd\left(\frac{b+c}{a}\right)$ But unlike quantities are those which are expressed by different letters, or by the same letters with different powers, as $2\,a\,b$, $5\,a\,b^2$, and $3\,a^2\,b$. When a quantity is expressed by a single letter, or by several single letters multiplied together, without any intervening sign, as a, or $2\,a\,b$, it is called a simple quantity. But the quantity which consists of two or more such simple quantities, connected by the signs $+$ or $-$, is called a compound quantity; thus, $a-2\,a\,b+5\,a\,b\,c$ is a compound

quantity; and the simple quantities, a, $2ab$, $5abc$, are called its terms or members. If a compound quantity consist of two terms, it is called a binomial; of three terms, a trinomial; of four terms, a quadrinomial, and of many terms, a multinomial. If one of the terms of a binomial be negative, the quantity is called a residual quantity. The reciprocal of any quantity is that quantity inverted, or unity divided by it; thus $\frac{a}{b}$ is the reciprocal of $\frac{b}{a}$, and $\frac{1}{a}$ is the reciprocal of a. The letters by which any simple quantity is expressed may be ranged at pleasure, and yet retain the same signification; thus ab and ba are the same quantity, the product of a and b being the same with that of b by a. The several terms of which any compound quantity consists may be disposed in any order at pleasure, provided they retain their proper signs. Thus $a-2ab+5a^2b$ may be written $a+5a^2b-2ab$, or $-2ab+a+5a^2b$, for all these represent the same thing or the quantity which remains, when from the sum of a and $5a^2b$, the quantity $2ab$ is deducted.

Axioms. 1. If equal quantities be added to equal quantities, the sums will be equal.

2. If equal quantities be taken from equal quantities, the remainders will be equal.

3. If equal quantities be multiplied by the same, or equal quantities, the products will be equal.

4. If equal quantities be divided by the same, or equal quantities, the quotients will be equal.

5. If the same quantity be added to and subtracted from another, the value of the latter will not be altered.

6. If a quantity be both multiplied and divided by another, its value will not be altered.

ADDITION OF ALGEBRAICAL QUANTITIES.

The addition of algebraical quantities is performed by connecting those that are unlike *with their proper signs, and collecting those that are* similar *into one sum.*

Add together the following unlike quantities:

$$\begin{array}{rl} \text{Ex. 1} & ax \\ & -bu \\ & +3z \\ & -2y \\ \hline \text{Ans.} & ax-bu+3z-2y \end{array}$$

$$\begin{array}{rl} \text{Ex. 2} & -a+b \\ & +3z-x \\ & -4y+3c \\ \hline \text{Ans.} & -a+b+3c-x-4y+3z \end{array}$$

It is immaterial in what order the quantities are set down, if we take care to prefix to each its proper sign.

When any terms are *similar*, they may be incorporated, and the general expression for the sum shortened.

1. When *similar* quantities have the *same* sign, their sum is found by taking the sum of the co-efficients with that sign, and annexing the common letters.

$$\begin{array}{rl} \text{Ex. 3.} & 4a-5b \\ & 2a-6b \\ & 9a-3b \\ \hline \text{Ans.} & 15a-14b \end{array}$$

$$\begin{array}{rl} \text{Ex. 4.} & 4a^2c-10bde \\ & 6a^2c-9bde \\ & 11a^2c-3bde \\ \hline \text{Ans.} & 21a^2c-22bde \end{array}$$

The reason is evident; $4a$ to be added, together with $2a$ and $9a$ to be added, makes $15a$ to be added; and $5b$ to be subtracted, together with $6b$ and $3a$ to be subtracted, is $14b$ to be subtracted.

2. If *similar* quantities have *different* signs, their sum is found by taking the difference of the co-efficients with the sign of the greater, and annexing the common letters as before.

$$\begin{array}{rl} \text{Ex. 5.} & 7a+3b \\ & -5a-9b \\ \hline \text{Ans.} & 2a-6b \end{array}$$

$$\begin{array}{rl} \text{Ex. 6.} & 6a+4b+9c \\ & -9a+3b+16c \\ & +12a-7b-20c \\ \hline \text{Ans.} & 9a \quad * \quad +5c \end{array}$$

In the first part of the operation we have 7 times a to add, and 5 times a to take away; therefore, upon the whole, we have $2a$ to add. In the latter part, we have 3 times b to add, and 9 times b to take away; *i. e.* we have, upon the whole, 6 times b to take away: and thus the sum of all the quantities is $2a-6b$.

If several similar quantities are to be added together, some with positive and some with negative signs, take the difference between the sum of the positive

and the sum of the negative co-efficients, prefix the sign of the greater sum, and annex the common letters.

$$\begin{array}{llllll}\text{Ex. 7.} & 3a^2 & +4bc & -e^2 & +10x & -25 \\ & -5a^2 & +6bc & +2e^2 & -15x & +44 \\ & -4a^2 & -9bc & -10e^2 & +21x & -90 \\ \hline \text{Ans.} & -6a^2 & +bc & -9e^2 & +16x & -71 \end{array}$$

$$\begin{array}{llllll}\text{Ex. 8.} & 4ac & -15bd & +ex & & -ax \\ & 11ac & +7b^2 & -19ex & & +4ax \\ & -41a^2 & +6bd & -7de & & -2ax \\ \hline \end{array}$$

$$\text{A. } 15ac-41a^2-9^2d+7b^2-18ex-7de-ax$$

$$\begin{array}{llll}\text{Ex. 9.} & px^3 & -qx^2 & -rx \\ & ax^3 & -bx^2 & -x \\ \hline \text{Ans.} & \overline{p+a}\,x^3 & -\overline{q+b}\,x^2 & -\overline{r+1}.x \end{array}$$

In this example, the co-efficients of x and its powers are united; $\overline{p+a}.x^3=px^3+ax^3$; also $-\overline{q+b}.x^2=-qx^2-bx^2$, because the negative sign affects the whole quantity under the vinculum; and $-\overline{r-1}.x=-rx-x$

SUBTRACTION.

Subtraction, or the taking away of one quantity from another, is performed by changing the sign of the quantity to be subtracted, and then adding it to the other, by the rules laid down in the last article.

Ex. 1. From $2bx$ take cy, and the difference is properly represented by $2bx-cy$; because the $-$ prefixed to cy shews that it is to be subtracted from the other; and $2bx-cy$ is the sum of $2bx$ and $-cy$.

Ex. 2. Again, from $2bx$ take $-cy$, and the difference is $2bx+cy$; because $2bx=2bx+cy-cy$, take away $-cy$ from these equal quantities, and the differences will be equal; *i. e.* the difference between $2bx$ and $-cy$ is $2bx+cy$, the quantity which arises from adding $+cy$ to $2bx$.

$$\begin{array}{ll}\text{Ex. 3. From} & a+b \\ \text{take} & a-b \\ \hline \text{Ans.} & * +2b \end{array}$$

$$\begin{array}{lll}\text{Ex. 4. From} & 6a & -12b \\ \text{take} & -5a & -10b \\ \hline \text{Ans.} & 11a & -2b \end{array}$$

$$\begin{array}{llll}\text{Ex. 5. From} & 5a^2 & +4ab & -6xy \\ \text{take} & 11a^2 & +6ab & -4xy \\ \hline \text{Ans.} & -6a^2 & -2ab & -2xy \end{array}$$

$$\begin{array}{ll}\text{Ex. 6. From} & 4a-3b+6c-11 \\ \text{take} & 10x+a-15-2y \\ \hline \text{Ans.} & 3a-3b+6c-10x+2y+4 \end{array}$$

$$\begin{array}{ll}\text{Ex. 7. From} & ax^3-bx^2+x \\ \text{take} & px^3-qx^2+rx \\ \hline \text{Ans.} & \overline{a-p}.x^3-\overline{b-q}.x^2+\overline{1-r}.x \end{array}$$

In this example the co-efficients are united; $\overline{a-p}.x^3$ is equal to bx^2-qx^3; $-\overline{b-q}.x^2$ is equal to bx^2-qx^2; and $\overline{1-r}.x=x-rx$.

MULTIPLICATION.

The multiplication of simple algebraical quantities must be represented according to the notation already pointed out.

Thus, $a\times b$, or ab, represents the product a multiplied by b; abc, the product of the three quantities, a, b, and c.

It is also indifferent in what order they are placed, $a\times b$ and $b\times a$ being equal.

To determine the *sign* of the product, observe the following rule.

If the multiplier and multiplicand have the same sign, the product is positive; if they have different *signs, it is negative.*

1. $+a\times+b=ab$; because in this case a is to be taken positively b times; therefore the product ab must be positive.

2. $-a\times+b=-ab$; because $-a$ is to be taken b times; that is, we must take $-ab$.

3. $+a\times-b=-ab$; for a quantity is said to be multiplied by a negative number $-b$, if it be subtracted b times; and a subtracted b times is $-ab$.

4. $-a\times-b=+ab$. Here $-a$ is to be subtracted b times; that is, $-ab$ is to be subtracted; but subtracting $-ab$ is the same as adding $+ab$; therefore we have to add $+ab$.

The 2d and 4th cases may be thus proved; $a-a=o$, multiply both sides by b, and a together with $-a\times b$ must be equal to $b\times o$, or nothing; therefore, $-a$ multiplied by b must give $-ab$, a quantity which when added to ab makes the sum nothing.

Again, $a-a=o$; multiply both sides by $-b$, then $-ab$ together with $-a\times-b$ must be $=o$; therefore $-a\times-b=+ab$.

If the quantities to be multiplied have co-efficients, these must be multiplied to-

gether, as in common arithmetic; the sign and the literal product being determined by the preceding rules.

Thus, $3a\times 5b=15ab$; because $3\times a\times 5\times b=3\times 5\times a\times b=15ab$; $4x\times -11y=-44xy$; $-9b\times -5c=+45bc$; $-6d\times 4m=-24md$.

The powers of the same quantity are multiplied together by *adding* the indices; thus $a^2\times a^3=a^5$; for $aa\times aaa=aaaaa$. In the same manner, $a^m\times a^n=a^{m+n}$; and $-3a^2x^3\times 5axy^2=-15a^3x^4y^2$.

If the multiplier or multiplicand consist of several terms, each term of the latter must be multiplied by every term of the former, and the sum of all the products taken, for the whole product of the two quantities.

Ex. 1. Mult. $a+b+x$
by $c+d$

Ans. $ac+bc+xc+ad+bd+xd$

Here $a+b+x$ is to be added to itself $c+d$ times, i. e. c times and d times.

Ex. 2. Mult. $a+b-x$
by $c-d$

Ans. $ac+bc-xc-ad-bd+xd$

Here $a+b$ is to be taken $c-d$ times, that is, c times wanting d times; or c times positively and d times negatively.

Ex. 3. Mult. $a+b$
by $a+b$

$$\begin{array}{r} a^2+ab \\ +ab+b^2 \\ \hline \end{array}$$

Ans. $a^3+2ab+b^2$

Ex. 4. Mult. $x+y$
by $x-y$

$$\begin{array}{r} x^2+xy \\ -xy-y^2 \\ \hline \end{array}$$

Ans. $x^2\quad * \quad -a^2$

Ex. 5. Mult. $3a^2-5bd$
by $-5a^2+4bd$

$$\begin{array}{r} -15a^4+25a^2bd \\ +12a^2bd-20b^2d^2 \\ \hline \end{array}$$

Ans. $-15a^4+37a^2bd-20b^2d^2$

Ex. 6. Mult. $a^2+2ab+b^2$
by $a^2-2ab+b^2$

$$\begin{array}{r} a^4+2a^3b+a^2b^2 \\ -2a^3b-4a^2b^2-2ab^3 \\ +a^2b^2+2ab^3+b^4 \\ \hline \end{array}$$

Ans. $a^4\quad * \quad -2a^2b^2\quad * \quad +b^4$

Ex. 7. Mult. $1-x+x^2-x^3$
by $1+x$

$$\begin{array}{r} 1-x+x^2-x^3 \\ +x-x^2+x^3-x^4 \\ \hline \end{array}$$

Ans. $1\quad * \quad * \quad * \quad -x^4$

Ex. 8. Mult. x^2-px+q
by $x+a$

$$\begin{array}{r} x^3-px^2+qx \\ +ax^2-apx+aq \\ \hline \end{array}$$

Ans. $x^3-\overline{p-a}.x^2+\overline{q-ap}.x+aq$

Here the co-efficients of x^2 and x are collected; $-\overline{p-a}.x^2=-px^2\ ax^2$; and $\overline{q-ap}.x=qx-apx$.

DIVISION.

To divide one quantity by another, is to determine how often the latter is contained in the former, or what quantity multiplied by the latter will produce the former.

Thus, to divide ab by a is to determine how often a must be taken to make up ab; that is, what quantity multiplied by a will give ab; which we know is b. From this consideration are derived all the rules for the division of algebraical quantities.

If the divisor and dividend be affected with *like* signs, the sign of the quotient is $+$: but if their signs be *unlike*, the sign of the quotient is $-$.

If $-ab$ be divided by $-a$, the quotient is $+b$; because $-a\times +b$ gives $-ab$; and a similar proof may be given in the other cases.

In the division of simple quantities, if the co-efficient and literal product of the divisor be found in the dividend, the other part of the dividend, with the sign determined by the last rule, is the quotient.

Thus, $\frac{abc}{ab}=c$; because ab multiplied by c gives abc.

If we first divide by a, and then by b, the result will be same; for $\frac{abc}{a}=bc$, and $\frac{bc}{a}=c$, as before.

Hence, any power of a quantity is divided by any other power of the same quantity, by subtracting the index of the divisor from the index of the dividend.

Thus, $\frac{a^5}{a^3}=a^2$; $\frac{a^5}{a^3}=\frac{1}{a^3}=a^{-3}$; $\frac{a^m}{a^n}=a^{m-n}$.

If only a part of the product which forms the divisor be contained in the divi-

dend, the quantities contained both in the divisor and dividend must be expunged. Thus, $15\,a^3\,b^2\,c$ divided by $-3\,a^2\,b\,x$, or $\frac{15\,a^3\,b^2\,c}{-3\,a^2\,b\,y}=\frac{-5\,a\,b\,c.}{y}$

First, divide by $-3\,a^2\,b$, and the quotient is $-5\,a\,b\,c$; this quantity is still to be divided by y, and as y is not contained in it, the division can only be represented in the usual way; that is, $\frac{-5\,a\,b\,c}{y}$ is the quotient.

If the dividend consist of several terms, and the divisor be a simple quantity, every term of the dividend must be divided by it.

Thus, $\frac{a^3\,x^2-5\,a\,b\,x^3+6\,a\,x^4}{a\,x^2}=a^2-5\,b\,x+6\,x^2$.

When the divisor also consists of several terms, arrange both the divisor and dividend according to the powers of some one letter contained in them; then find how often the first term of the divisor is contained in the first term of the dividend, and write down this quantity for the first term in the quotient; multiply the whole divisor by it, subtract the product from the dividend, and bring down to the remainder as many other terms of the dividend as the case may require, and repeat the operation till all the terms are brought down.

Ex. 1. If $a^2-2\,a\,b+b^2$ be divided by $a-b$, the operation will be as follows:

$$a-b)a^2-2\,a\,b+b^2(a-b$$
$$a^2-a\,b$$
$$-a\,b+b^2$$
$$-a\,b+b^2$$
$$*\quad *$$

The reason of this, and the foregoing rule, is, that as the whole dividend is made up of all its parts, the divisor is contained in the whole, as often as it is contained in all the parts. In the preceding operation we inquire, first, how often a is contained in a^2, which gives a for the first term of the quotient, then multiplying the whole divisor by it, we have $a^2-a\,b$ to be subtracted from the dividend, and the remainder is $-a\,b+b^2$, with which we are to proceed as before.

The whole quantity $a^2-2\,a\,b+b^2$ is in reality divided into two parts by the process, each of which is divided by $a-b$; therefore the true quotient is obtained.

Ex. 2 $a+b)a\,c+a\,d+b\,c+b\,d(c+d$
$$a\,c+b\,c$$
$$a\,d+b\,d$$
$$a\,d+b\,d$$
$$*\quad *$$

Ex. 3.

$$1-x)1\,(1+x+x^2+x^3+\&c.+\frac{\text{Remainder}}{1-x}$$
$$1-x$$
$$+x$$
$$+x-x^2$$
$$+x^2$$
$$+x^2-x^3$$
$$+x^3$$
$$+x^3-x^4$$
$$+x^4\ \&c.$$

Ex. 4. $y-1\,)y^3-1(\,y^2+y+1$
$$y^3-y^2$$
$$+y^2$$
$$y^2-y$$
$$+y-1$$
$$y-1$$
$$*$$

Ex. 5.

$$x-a\,)x^3-px^2+qx-r(\,x^2+\overline{a-p}\,x+a^2-pa+q$$
$$x^3-ax^2$$
$$\overline{a-p}\,x^2+qx$$
$$\overline{a-p}\,x^2-\overline{a^2-pa}\,x$$
$$+\overline{a^2-pa+q}\,x-r$$
$$\overline{a^2-pa+q}\,.x-\overline{a^3-pa^2+qa}$$
$$\text{Remainder } a^3-pa^2+qa-r$$

ON THE TRANSFORMATION OF FRACTIONS TO OTHERS OF EQUAL VALUE.

If the signs of all the terms both in the numerator and denominator of a fraction be changed, its value will not be altered. For $\frac{-a\,b}{-a}=+b=\frac{+a\,b}{+a}$; and $\frac{a\,b}{-a}=-b=\frac{-a\,b.}{a}$

If the numerator and denominator of a fraction be both multiplied, or both divided, by the same quantity, its value is not altered. For $\frac{a\,c}{b\,c}=\frac{a}{b}$; and $\frac{a\,x\,y\,z}{a\,b\,c\,z}=\frac{x\,y}{b\,c}$.

Hence, a fraction is reduced to its lowest terms, by dividing both the numera-

tor and denominator by the greatest quantity that measures them both.

The greatest common measure of two quantities is found by arranging them according to the powers of some letter, and then dividing the greater by the less, and the preceding divisor always by the last remainder, till the remainder is nothing; the last divisor is the greatest common measure required.

Let a and b be the two quantities, and let b be contained in a, p times, with a remainder c; again, let c be contained in b, q times, with a remainer d, and so on, till nothing remains; let d be the last divisor, and it will be the greatest common measure of a and b.

$$\begin{array}{l} b)\,a\,(p \\ \underline{\quad} \\ c)\,b\,(q \\ \underline{\quad} \\ d)\,c\,(r \\ \underline{\quad} \\ 0 \end{array}$$

The truth of this rule depends upon these two principles:

1. If one quantity measure another, it will also measure any multiple of that quantity Let x measure y by the units in n, then it will measure $c\,y$ by the units in $n\,c$.

2. If a quantity measure two others, it will measure their sum or difference. Let a be contained in x, m times, and in y, n times; then $m\,a = x$ and $n\,a = y$; therefore $x \pm y = m\,a \pm n\,a = \overline{m \pm n}\,.\,a$; i. e. a is contained in $x \pm y$, $m \pm n$ times, or it measures $x \pm y$ by the units in $m \pm n$.

Now it appears from what has been said, that $a - p\,b = c$, and $b - q\,c = d$; every quantity therefore, which measures a and b, measures $p\,b$, and $a - p\,b$, or c; hence also it measures $q\,c$, and $b - q\,c$, or d; that is, every common measure of a and b measures d.

Ex. To find the greatest common measure of $a^4 - x^4$ and $a^3 - a^2x - a\,x^2 + x^3$, and to reduce $\dfrac{a^4 - x^4}{a^3 - a^2x - ax^2 + x^3}$ to its lowest terms.

$$\begin{array}{r} a^3-a^2x-ax^2+x^3)\,a^4-x^4\,(a+x \\ \underline{a^4-a^3x-a^2x^2+ax^3} \\ a^3x+a^2x^2-ax^3-x^4 \\ \underline{a^3x-a^2x^2-ax^3+x^4} \\ \underline{2a^2x^2-2x^4} \end{array}$$

leaving out $2\,x^2$, which is found in each term of the remainder, the next divisor is $a^2 - x^2$.

$$\begin{array}{r} a^2-x^2)\,a^3-a^2x-ax^3+x^2(a-x \\ \underline{a^3-a\,x^2} \\ -a^2x+x^3 \\ \underline{-a^2x+x^4} \\ \underline{*} \end{array}$$

$a^2 - x^2$ is therefore the greatest common measure of the two quantities, and if they be respectively divided by it, the fraction is reduced to $\dfrac{a^2+x^2}{a-x}$, its lowest terms.

The quantity $2\,x^2$, found in every term of one of the divisors, $2\,a^2x^2 - 2\,x^4$, but not in every term of the dividend, $a^3 - a^2x - ax^2 + x^3$, must be left out; otherwise the quotient will be fractional, which is contrary to the supposition made in the proof of the rule; and by omitting this part, $2\,x^2$, no common measure of the divisor and dividend is left out; because, by the supposition, no part of $2\,x^2$ is found in all the terms of the dividend.

To find the greatest common measure of three quantities, $a\,b\,c$; take d the greatest common measure of a and b, and the greatest measure of d and c is the greatest common measure required. In the same manner, the greatest common measure of four or more quantities may be found.

If one number be divided by another, and the preceding divisor by the remainder, according to what has been said, the remainder will at length be less than any quantity that can be assigned.

Fractions are changed to others of equal value with a common denominator, by multiplying each numerator by every denominator except its own, for the new numerator; and all the denominators together for the common denominator.

Let $\frac{a}{b}, \frac{c}{d}, \frac{e}{f}$ be the proposed fractions; then $\frac{a\,d\,f}{b\,d\,f}, \frac{c\,b\,f}{b\,d\,f}, \frac{e\,d\,b}{b\,d\,f}$, are fractions of the same value with the former, having the common denominator $b\ d\ f$. For $\frac{a\,d\,f}{b\,d\,f} = \frac{a}{b}$; $\frac{c\,b\,f}{b\,d\,f} = \frac{c}{d}$; and $\frac{e\,d\,b}{b\,d\,f} = \frac{e}{f}$, the numerator and denominator of each fraction having been multiplied by the same quantity, *viz.* the product of the denominators of all the other fractions.

When the denominators of the proposed fractions are not prime to each other, find their greatest common measure; multiply both the numerator and deno-

minator of each fraction by the denominators of all the rest, divided respectively by their greatest common measure; and the fractions will be reduced to a common denominator, in lower terms than they would have been by proceeding according to the former rule.

Thus, $\frac{a}{m\,x}, \frac{b}{m\,y}, \frac{c}{m\,z}$, reduced to a common denominator, are $\frac{a\,y\,z}{m\,x\,y\,z}$; $\frac{b\,x\,z}{m\,x\,y\,z}$; $\frac{c\,x\,y}{m\,x\,y\,z}$.

ON THE ADDITION AND SUBTRACTION OF FRACTIONS.

If the fractions to be added have a common denominator, their sum is found by adding the numerators together, and retaining the common denominator. Thus,

$$\frac{a}{b}+\frac{c}{b}=\frac{a+c}{b}.$$

If the fractions have not a common denominator, they must be transformed to others of the same value, which have a common denominator, and then the addition may take place as before.

Ex. 2. $\frac{a}{b}+\frac{c}{d}=\frac{a\,d}{b\,d}+\frac{b\,c}{b\,d}=\frac{a\,d+b\,c}{b\,d}$.

Ex. 3. $\frac{1}{a+b}+\frac{1}{a-b}=\frac{a-b}{a^2-b^2}+\frac{a+b}{a^2-b^2}=\frac{a-b+a+b}{a^2-b^2}=\frac{2\,a}{a^2-b^2}$.

Ex. 4. $a+\frac{e}{f}=\frac{a\,f}{f}+\frac{e}{f}=\frac{a\,f+e}{f}$. Here a is considered as a fraction whose denominator is unity.

If two fractions have a common denominator, their difference is found by taking the difference of the numerators, and retaining the common denominator. Thus,

$$\frac{a}{b}-\frac{c}{b}=\frac{a-c}{b}.$$

If they have not a common denominator, they must be transformed to others of the same value which have a common denominator, and then the subtraction may take place as above.

Ex. 2. $\frac{a}{b}-\frac{c}{d}=\frac{a\,d}{b\,d}-\frac{b\,c}{b\,d}=\frac{a\,d-b\,c}{b\,d}$.

Ex. 3. $a-\frac{c\,d}{b}=\frac{a\,b}{b}-\frac{c\,d}{b}=\frac{a\,b-c\,d}{b}$.

Ex. 4. $\frac{a}{b}-\frac{c+d}{c-d}=\frac{a\,c-a\,d}{b\,c-b\,d}-\frac{b\,c+b\,d}{b\,c-b\,d}=\frac{a\,c-a\,d-b\,c-b\,d}{b\,c-b\,d}$.

The sign of $b\,d$ is negative, because every part of the latter fraction is to be taken from the former.

ON THE MULTIPLICATION AND DIVISION OF FRACTIONS.

To multiply a fraction by any quantity; multiply the numerator by that quantity, and retain the denominator.

Thus, $\frac{a}{b}\times c=\frac{a\,c}{b}$. For if the quantity to be divided be c times as great as before, and the divisor the same, the quotient must be c times as great.

The product of two fractions is found by multiplying the numerators together for a new numerator, and the denominators for a new denominator.

Let $\frac{a}{b}$ and $\frac{c}{d}$ be the two fractions; then $\frac{a}{b}\times\frac{c}{d}=\frac{a\,c}{b\,d}$. For if $\frac{a}{b}=x$ and $\frac{c}{d}=y$, by multiplying the equal quantities $\frac{a}{b}$ and x, by b, $a=b\,x$; in the same manner, $c=dy$; therefore $a\,c=b\,d\,x\,y$; dividing these equal quantities, $a\,c$ and $b\,d\,x\,y$, by $b\,d$, we have $\frac{a\,c}{b\,d}=x\,y=\frac{a}{b}\times\frac{c}{d}$.

To divide a fraction by any quantity, multiply the denominator by that quantity, and retain the numerator.

The fraction $\frac{a}{b}$ divided by c, is $\frac{a}{b\,c}$. Because $\frac{a}{b}=\frac{a\,c}{b\,c}$, and a c^{th} part of this is $\frac{a}{b\,c}$; the quantity to be divided, being a c^{th} part of what it was before, and the divisor the same.

The result is the same, whether the denominator is multiplied by the quantity, or the numerator divided by it.

Let the fraction be $\frac{a\,c}{b\,d}$; if the denomi-

nator be multiplied by c, it becomes $\frac{ac}{bdc}$ or $\frac{a}{bd}$; the quantity which arises from the division of the numerator by c.

To divide one fraction by another, invert the numerator and denominator of the divisor, and proceed as in multiplication.

Let $\frac{a}{b}$ and $\frac{c}{d}$ be the two fractions, then $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$.

For if $\frac{a}{b} = x$, and $\frac{c}{d} = y$, then $a = bx$, and $c = dy$; also, $ad = bdx$, and $bc = bdy$; therefore $\frac{ad}{bc} = \frac{bdx}{bdy} = \frac{x}{y} = \frac{a}{b} \div \frac{c}{d}$.

The rule for multiplying the powers of the same quantity will hold, when one or both of the indices are negative.

Thus, $a^m \times a^{-n} = a^{m-n}$; for $a^m \times a^{-n} = a^m \times \frac{1}{a^n} = \frac{a^m}{a^n} = a^{m-n}$; in the same manner, $x^3 \times x^{-5} = \frac{x^3}{x^5} = \frac{1}{x^2} = x^{-2}$.

Again, $a^{-m} \times a^{-n} = a^{-\overline{m+n}}$; because $a^{-m} \times a^{-n} = \frac{1}{a^m} \times \frac{1}{a^n} = \frac{1}{a^{m+n}} = a^{-\overline{m+n}}$

If $m = n$, $a^m \times a^{-m} = a^{m-m} = a^0$; also, $a^m \times a^{-m} = \frac{a^m}{a^m} = 1$; therefore $a^0 = 1$; according to the notation adopted.

The rule for dividing any power of a quantity by any other power of the same quantity holds, whether those powers are positive or negative.

Thus, $a^m \div a^{-n} = a^m \div \frac{1}{a^n} = a^m \times a^n = a^{m+n}$.

Again, $a^{-m} \div a^{-n} = \frac{1}{a^m} \div \frac{1}{a^n} = \frac{a^n}{a^m} = a^{m+n}$.

Hence it appears, that a quantity may be transferred from the numerator of a fraction to the denominator, and the contrary, by changing the sign of its index. Thus, $\frac{a^m \times a^n}{b^p} = \frac{a^m}{b^p\, a^{-n}}$; and $\frac{a^m}{a^n\, b^p} = \frac{a^m \times a^{-n}}{b^p}$

ON INVOLUTION AND EVOLUTION.

Involution. If a quantity be continually multiplied by itself, it is said to be involved or raised; and the power to which it is raised is expressed by the number of times the quantity has been employed in the multiplication.

Thus, $a \times a$, or a^2, is called the second power of a; $a \times a \times a$, or a^3, the third power, $a \times a \ldots (n)$, or a^n, the n^{th} power.

If the quantity to be involved be negative, the signs of the even powers will be positive, and the signs of the odd power negative.

For $-a \times -a = a^2$; $-a \times -a \times -a = -a^3$, &c.

A simple quantity is raised to any power, by multiplying the index of every factor in the quantity by the exponent of the power, and prefixing the proper sign determined by the last article.

Thus, a^m raised to the n^{th} power is a^{mn}, Because $a^m \times a^m \times a^m \ldots$ to n factors, by the rule of multiplication, is a^{mn}; also, $\overline{ab}|^n = ab \times ab \times ab \times$ &c. to n factors, or $a \times a + a \ldots$ to n factors $\times b \times b \times b \ldots$ to n factors $= a^n \times b^n$; and $a^2\, b^3\, c$ raised to the fifth power is $a^{10}\, b^{15}\, c^5$. Also, $-a^m$ raised to the n^{th} power is $\pm a^{mn}$; where the positive or negative sign is to be prefixed, according as n is an even or odd number.

If the quantity to be involved be a fraction, both the numerator and denominator must be raised to the proposed power.

If the quantity proposed be a compound one, the involution may either be represented by the proper index, or it may actually take place.

Let $a+b$ be the quantity to be raised to any power.

$$\begin{array}{l}
a+b \\
a+b \\
\hline
a^2+ab \\
\quad +ab+b^2 \\
\hline
\end{array}$$

$\overline{a \times b}|^2$ or $a^2+2ab+b^2$ the sq. or 2[d] power

$$\begin{array}{l}
a+b \\
\hline
a^3+2a^2b+ab^2 \\
\quad +a^2b+2ab^2+b^3 \\
\hline
\end{array}$$

$\overline{a+b}|^3$ or $a^3+3a^2b+3ab^2+b^3$ the 3[d] pr.

$$\begin{array}{l}
a+b \\
\hline
a^4+3a^3b+3a^2b^2+ab^3 \\
\quad +a^3b+3a^2b^2+3ab^3+b^4 \\
\hline
\end{array}$$

$\overline{a+b}|^4$ or $a^4+4a^3b+6a^2b^2+4ab^3+b^4$ the fourth power.

If b be negative, or the quantity to be involved be $a-b$, wherever an odd power of b enters, the sign of the term must be negative.

Hence, $\overline{a-b}|^4 = a^4 - 4a^3b + 6a^2b^2 - 4ab^3 + b^4$.

Evolution, or the extraction of roots, is the method of determining a quantity, which, raised to a proposed power, will produce a given quantity.

Since the n^{th} power of a^m is a^{mn}, the n^{th} root of a^{mn} must be a^m; *i. e.* to extract any root of a single quantity, we must divide the index of that quantity by the index of the root required.

When the index of the quantity is not exactly divisible by the number which expresses the root to be extracted, that root must be represented according to the notation already pointed out.

Thus the square, cube, fourth, n^{th} root of a^2+x^2, are respectively represented by $(a^2+x^2)^{\frac{1}{2}}$, $(a^2+x^2)^{\frac{1}{3}}$, $(a^2+x^2)^{\frac{1}{4}}$, $(a^2+x^2)^{\frac{1}{n}}$; the same roots of $\frac{1}{a^2+x^2}$, or $(a^2+x^2)^{-1}$, are represented by $(a^2+x^2)^{-\frac{1}{2}}$, $(a^2+x^2)^{-\frac{1}{3}}$, $(a^2+x^2)^{-\frac{1}{4}}$, $(a^2+x^2)^{-\frac{1}{n}}$.

If the root to be extracted be expressed by an odd number, the sign of the root will be the same with the sign of the proposed quantity.

If the root to be extracted be expressed by an even number, and the quantity proposed be positive, the root may be either positive or negative. Because either a positive or negative quantity, raised to such a power, is positive.

If the root proposed to be extracted be expressed by an even number, and the sign of the proposed quantity be negative, the root cannot be extracted; because no quantity, raised to an even power, can produce a negative result. Such roots are called impossible.

Any root of a product may be found by taking that root of each factor, and multiplying the roots, so taken, together.

Thus, $(ab)^{\frac{1}{n}}=a^{\frac{1}{n}}\times b^{\frac{1}{n}}$; because each of these quantities, raised to the n^{th} power, is ab.

In $a=b$, then $a^{\frac{1}{n}}\times a^{\frac{1}{n}}=a^{\frac{2}{n}}$; and in the same manner $a^{\frac{r}{n}}\times a^{\frac{s}{n}}=a^{\frac{r+s}{n}}$.

Any root of a fraction may be found by taking that root both of the numerator and denominator. Thus, the cube root of $\frac{a^2}{b^2}$ is $\frac{a^{\frac{2}{3}}}{b^{\frac{2}{3}}}$, or $a^{\frac{2}{3}}\times b^{-\frac{2}{3}}$; and $\left(\frac{a}{b}\right)^{\frac{1}{n}}=\frac{a^{\frac{1}{n}}}{b^{\frac{1}{n}}}$, or $a^{\frac{1}{n}}\times b^{-\frac{1}{n}}$.

To extract the square root of a compound *quantity.*

$$
\begin{array}{l}
a^2+2ab+b^2\ (a+b \\
a^2 \\
\hline
2a+b)\ 2ab+b^2 \\
\qquad\ \ 2ab+b^2 \\
\hline
\qquad\ \ * \quad *
\end{array}
$$

Since the square root of $a^2+2ab+b^2$ is $a+b$, whatever be the values of a and b, we may obtain a general rule for the extraction of the square root, by observing in what manner a and b may be derived from $a^2+2ab+b^2$.

Having arranged the terms according to the dimensions of one letter, a, the square root of the first term a^2 is a, the first factor in the root; subtract its square from the whole quantity, and bring down the remainder $2ab+b^2$; divide $2ab$ by $2a$, and the result is b, the other factor in the root; then multiply the sum of twice the first factor and the second $(2a+b)$, by the second (b), and subtract this product $(2ab+b^2)$ from the remainder. If there be no more terms, consider $a+b$ as a new value of a; and the square, that is $a^2+2ab+b^2$, having, by the first part of the process, been subtracted from the proposed quantity, divide the remainder by the double of this new value of a, for a new factor in the root; and for a new subtrahend, multiply this factor by twice the sum of the former factors increased by this factor. The process must be repeated till the root, or the necessary approximation to the root, is obtained.

Ex. 1. To extract the square root of $a^2+2ab+b^2+2ac+2bc+c^2$.

$$
\begin{array}{l}
a^2+2ab+b^2+2ac+2bc+c^2\ (a+b+c \\
a^2 \\
\hline
2a+b)\ 2ab+b^2 \\
\qquad\quad 2ab+b^2 \\
\hline
2a+2b+c)\ * \quad * \quad 2ac+2bc+c^2 \\
\qquad\qquad\qquad\quad 2ac+2bc+c^2 \\
\hline
\qquad\qquad\qquad\quad * \quad * \quad *
\end{array}
$$

Ex. 2. To extract the square root of $a^2-ax+\frac{x^2}{4}$

$$
\begin{array}{l}
a^2-ax+\frac{x^2}{4}\ \left(a-\frac{x}{2}\right. \\
a^2 \\
\hline
2a-\frac{x}{2}\Big)\ -ax+\frac{x^2}{4} \\
\qquad\quad\ -ax+\frac{x^2}{4} \\
\hline
\qquad\qquad * \quad *
\end{array}
$$

Ex. 3. To Extract the square root of $1+x$.

$$1+x\,(1+\frac{x}{2}-\frac{x^2}{8}\ \&c.$$
$$1$$
$$2+\frac{x}{2})\quad x$$
$$x+\frac{x^2}{4}$$
$$2+x-\frac{x^2}{8})\quad -\frac{x^2}{4}$$
$$-\frac{x^2}{4}-\frac{x^3}{8}+\frac{x^4}{64}$$
$$\frac{x^3}{8}-\frac{x^4}{64}\ \&c.$$

It appears from the second example, that a trinomial $a^2-a\,x+\frac{x^2}{4}$, in which four times the product of the first and last terms is equal to the square of the middle term, and a complete square, or $a^2\times\frac{x^2}{4}\times 4=a^2\,x^2$.

The method of extracting the cube root is discovered in the same manner.

$$a^3+3\,a^2\,b+3\,a\,b^2+b^3\ (a+b$$
$$a^3$$
$$3\,a^2)\quad 3\,a^2\,b+3\,a\,b^2+b^3$$
$$3\,a^2\,b+3\,a\,b^2+b^3$$
$$\bullet$$

The cube root of $a^3+3\,a^2\,b+3\,a\,b^2+b^3$ is $a+b$; and to obtain $a+b$ from this compound quantity, arrange the terms as before, and the cube root of the first term, a^3, is a, the first factor in the root; subtract its cube from the whole quantity, and divide the first term of the remainder by $3\,a^2$, the result is b, the second factor in the root; then subtract $3\,a^2\,b+3\,a\,b^2+b^3$ from the remainder, and the whole cube of $a+b$ has been subtracted. If any quantity be left, proceed with $a+b$ as a new a, and divide the last remainder by $3\,.\overline{a+b}|^2$ for a third factor in the root; and thus any number of factors may be obtained.

ON SIMPLE EQUATIONS.

If one quantity be equal to another, or to nothing, and this equality be expressed algebraically, it constitutes an *equation*. Thus, $x-a=b-x$ is an equation, of which $x-a$ forms one side, and $b-x$ the other.

When an equation is cleared of fractions and surds, if it contain the first power only of an unknown quantity, it is called a *simple equation*, or an equation of one dimension: if the *square* of the unknown quantity be in any term, it is called a *quadratic*, or an equation of two dimensions; and in general, if the index of the highest power of the unknown quantity be n, it is called *an equation of* n *dimensions*.

In any equation quantities may be transposed from one side to the other, if their signs be changed, and the two sides will still be equal.

Let $x+10=15$, then by subtracting 10 from each side, $x+10-10=15-10$ or $x=15-10$.

Let $x-4=6$, by adding 4 to each side, $x-4+4=6+4$, or $x=6+4$.

If $x-a+b=y$; adding $a-b$ to each side, $x-a+b+a-b=y+a-b$; or $x=y+a-b$.

Hence, if the signs of *all* the terms on each side be changed, the two sides will still be equal.

Let $x-a=b-2\,x$; by transposition, $-b+2\,x=-x+a$; or $a-x=2\,x-b$.

If every term, on each side, be multiplied by the same quantity, the results will be equal.

An equation may be cleared of fractions, by multiplying every term, successively, by the denominators of those fractions, excepting those terms in which the denominators are found.

Let $3\,x+\frac{5\,x}{4}=34$; multiplying by 4, $12\,x+5\,x=136$, or $17\,x=136$.

If each side of an equation be divided by the same quantity, the results will be equal.

Let $17\,x=136$; then $x=\frac{136}{17}=8$.

If each side of an equation be raised to the same power, the results will be equal.

Let $x^{\frac{1}{2}}=9$; then $x=9\times 9=81$.

Also, if the same root be extracted on both sides, the results will be equal.

Let $x=81$; then $x^{\frac{1}{2}}=9$.

To find the value of an unknown quantity in a simple equation.

Let the equation first be cleared of fractions, then transpose all the terms which involve the unknown quantity to one side of the equation, and the known quantities to the other; divide both sides by the co-efficient, or sum of the co-efficients, of

the unknown quantity, and the value required is obtained.

Ex. 1. To find the value of x in the equation $3x-5=23-x$.

by transp. $3x+x=23+5$

or $4x=28$

by division $x=\frac{28}{4}=7$.

Ex. 2. Let $x+\frac{x}{2}-\frac{x}{3}=4x-17$.

Mult. by 2, and $2x+x-\frac{2x}{3}=8x-34$

Mult. by 3, and $6x+3x-2x=24x-102$

by transp. $6x+3x-2x-24x=-102$

or $-17x=-102$

$17x=102$

$x=\frac{102}{17}=6$.

Ex. 3. $\frac{1}{a}+\frac{b}{x}=c$.

$1+\frac{ba}{x}=ca$

$x+ba=cax$

$x-cax=-bd$

or $cax-x=ba$

i. e. $\overline{ca-1}.\,x=ba$

$x=\frac{ba}{ca-1}$.

Ex. 4. $5-\frac{x+4}{11}=x-3$.

$55-x-4=11x-33$.

$55-4+33=11x+x$

$84=12x$

$x=\frac{84}{12}=7$.

Ex. 5. $x+\frac{3x-5}{2}=12-\frac{2x-4}{3}$.

$2x+3x-5=24-\frac{4x-8}{3}$

$6x+9x-15=72-4x+8$

$6x+9x+4x=72+8+15$

$19x=95$

$x=\frac{95}{19}=5$.

If there be two independent simple equations involving two unknown quantities, they may be reduced to one which involves only one of the unknown quantities, by any of the following methods:

1st Method. In either equation find the value of one of the unknown quantities in terms of the other and known quantities, and for it substitute this value in the other equation, which will then only contain one unknown quantity, whose value may be found by the rules before laid down.

Let $\left\{\begin{array}{l}x+y=10\\2x-3y=5\end{array}\right\}$ To find x and y.

From the first equat. $x=10-y$; hence, $2x=20-2y$,

by subst. $20-2y-3y=5$

$20-5=2y+3y$

$15=5y$

$y=\frac{15}{5}=3$

hence also, $x=10-y=10-3=7$.

2d Method. Find an expression for one of the unknown quantities in each equation; put these expressions equal to each other, and from the resulting equation the other unknown quantity may be found.

Let $\left\{\begin{array}{l}x+y=a\\bx+cy=de\end{array}\right\}$ To find x and y.

From the first equat. $x=a-y$

from the second, $bx=de-cy$, and $x=\frac{de-cy}{b}$

therefore $a-y=\frac{de-cy}{b}$

$ba-by=de-cy$

$cy-by=de-ba$

$\overline{c-b}.\,y=de-ba$

$y=\frac{de-bn}{c-b}$.

Also, $x=a-y$; that is,

$x=a-\frac{de-ba}{c-b}=\frac{ca-ba-de+ba}{c-b}=\frac{ca-de}{c-b}$.

3d Method. If either of the unknown quantities have the same co-efficient in both equations, it may be exterminated by subtracting, or adding, the equations, according as the sign of the unknown quantity, in the two cases, is the same or different.

Let $\left\{\begin{array}{l}x+y=15\\x-y=7\end{array}\right\}$ To find x and y.

By subtraction, $2y=8$, and $y=4$

By addition, $2x=22$, and $x=11$.

If the co-efficients of the unknown quantity to be exterminated be different, multiply the terms of the first equation by the co-efficient of the unknown quantity in the second, and the terms of the second equation by the co-efficient of the same unknown quantity in the first; then add, or subtract, the resulting equations, as in the former case.

Ex. 1. Let $\left\{\begin{array}{l}3x-5y=13\\2x+7y=81\end{array}\right\}$ To find x and y.

Multiply the terms of the first equation by 2, and the terms of the other by 3,

$$\text{then } 6x-10y=26$$
$$6x+21y=243$$

By subtraction, $-31y=-217$

$$\text{and } y=\frac{217}{31}=7;$$

also, $3x-5y=13$, or $3x-35=13$, therefore $3x=13+35=48$

$$\text{and } x=\frac{48}{3}=16$$

Ex. 2. Let $\left\{\begin{array}{l}ax+by=c\\mx-ny=d\end{array}\right\}$ To find x and y.

From the first, $max+mby=mc$
from the other, $max-nay=ad$
by subtraction, $mby+nay=mc-ad$,

$$\text{therefore, } y=\frac{mc-ad}{mb+na}.$$

Again, $nax+nby=nc$
$mbx-nby=bd$

by addition, $\overline{na+mb}.x=nc+bd$,

$$\text{therefore } x=\frac{nc+bd}{na+mb}.$$

If there be three independent simple equations, and three unknown quantities, reduce two of the equations to one, containing only two of the unknown quantities, by the preceding rules; then reduce the third equation and either of the former to one, containing the same two unknown quantities; and from the two equations thus obtained, the unknown quantities which they involve may be found. The third quantity may be found by substituting their values in any of the proposed equations.

Ex. Let. $\left\{\begin{array}{l}2x+3y+4z=16\\3x+2y-5z=8\\5x-6y+3z=6\end{array}\right\}$ To find x, y, and z.

From the 21st equa. $6x+ny+12z=48$
$6x+4y-10z=16$
by subtr. $5y-22z=32$
from the 1st and 3rd $10x+15y+20z=80$
$10x-12y+6z=12$
by subtr. $27y+14z=68$
and $5y+22z=32$
hence $135y+70z=340$
and $135y+594z=864$
by subtr. $524z=524$
$z=1$
$5y+22z=32$
that is, $5y+22=32$
$5y=32-22=10$

$$y=\frac{10}{5}=2$$

$2x+3y+4z=16$
that is, $2x+6+4=16$
$2x=16-6-4=6$
$x=3.$

The same method may be applied to any number of simple equations.

That the unknown quantities may have definite values, there must be as many independent equations as unknown quantities.

Thus, if $x+y=a$, $x=a-y$; and assuming y at pleasure, we obtain a value of x, such that $x+y=a$.

These equations must also be independent, that is, not deducible one from another.

Let $x+y=a$, and $2x+2y=2a$; this latter equation being deducible from the former, it involves no different supposition, nor requires any thing more for its truth, than that $x+y=a$ should be a just equation.

PROBLEMS WHICH PRODUCE SIMPLE EQUATIONS.

From certain quantities which are known, to investigate others which have a given relation to them, is the business of Algebra.

When a question is proposed to be resolved, we must first consider fully its meaning and conditions. Then substituting for such unknown quantities as appear most convenient, we must proceed as if they were already determined, and we wished to try whether they would answer all the proposed conditions or not, till as many independent equations arise as we have assumed unknown quantities, which will always be the case, if the question be properly limited; and by the solution of these equations, the quantities sought will be determined.

Prob. 1. To divide a line of 15 inches into two such parts, that one may be three-fourths of the other.

Let $4x$ = one part,
then $3x$ = the other.
$7x=15$, by the question,

$$x=\frac{15}{7}$$

$$4x=\frac{60}{7}=8\frac{4}{7}, \text{ one part,}$$

$$3x=\frac{45}{7}=6\frac{3}{7}, \text{ the other,}$$

Prob. 2. If A can perform a piece of work in 8 days, and B in 10 days, in what time will they finish it together?

Let x be the time required.

In one day, A performs $\frac{1}{8}$ part of the work; therefore, in x days, he performs $\frac{x}{8}$ parts of it; and in the same time, B performs $\frac{x}{10}$ parts of it; and calling the work 1,

$$\frac{x}{8}+\frac{x}{10}=1.$$
$$10x+8x=80$$
$$18x=80$$
$$x=\frac{80}{18}=4\frac{8}{18}=4\frac{4}{9}\text{ days.}$$

Prob. 3. A and B play at bowls, and A bets B three shillings to two upon every game; after a certain number of games, it appears that A has won three shillings; but had he ventured to bet five shillings to two, and lost one game more out of the same number, he would have lost thirty shillings: how many games did they play?

Let x be the number of games A won,
y the number B won,
then $2x$ is what A won of B,
and $3y$ what B won of A.
$2x-3y=3$, by the question;
$\overline{x-1}\,.\,2$, A would win on the 2[d] supposition
$\overline{y+1}\,.\,5$, B would win,
$5y+5-2x+2=30$, by the question;
or $5y-2x=30-5-2=23$,
therefore, $5y-2x=23$
and $2x-3y=3$
by addition, $5y-3y=26$
$2y=26$
$y=13$
$2x=3+3y=3+39=42$
$x=21$
$x+y=34$, the number of games.

ON QUADRATIC EQUATIONS.

When the terms of an equation involve the square of an unknown quantity, but the first power does not appear, the value of the square is obtained by the preceding rules; and by extracting the square root on both sides, the quantity itself is found.

Ex. 1. Let $5x^2-45=0$; to find x.
By trans. $5x^2=45$
$x^2=9$
therefore, $x=\sqrt{9}=\pm 3$.

The signs $+$ and $-$ are both prefixed to the root, because the square root of a quantity may be either positive or negative. The sign of x may also be negative; but still x will be either equal to $+3$ or -3,

Ex. 2. Let $a x^2=b c d$; to find x.

$$x^2=\frac{b c d}{a}$$
$$x=\pm\sqrt{\left(\frac{b c d}{a}\right)}$$

If both the first and second powers of the unknown quantity be found in an equation: Arrange the terms according to the dimensions of the unknown quantity, beginning with the highest, and transpose the known quantities to the other side; then, if the square of the unknown quantity be affected with a co-efficient, divide all the terms by this co-efficient, and if its sign be negative, change the signs of all the terms, that the equation may be reduced to this form, $x^2\pm p x=\pm q$. Then add to both sides the square of half the co-efficient of the first power of the unknown quantity, by which means the first side of the equation is made a complete square, and the other consists of known quantities; and by extracting the square root on both sides, a simple equation is obtained, from which the value of the unknown quantity may be found.

Ex. 1. Let $x^2+p x=q$; now, we know that $x^2+p x+\frac{p^2}{4}$ is the square of $x+\frac{p}{2}$, add therefore, $\frac{p^2}{4}$ to both sides, and we have $x^2+p x+\frac{p^2}{4}=q+\frac{p^2}{4}$; then by extracting the square root on both sides,

$$x+\frac{p}{2}=\pm\sqrt{\left(q+\frac{p^2}{4}\right)}\text{ and by trans.}$$
$$x=-\frac{p}{2}\pm\sqrt{\left(q+\frac{p^2}{4}\right)}$$

In the same manner, if $x^2-p x=q$, x is found to be $\frac{p}{2}\pm\sqrt{\left(q+\frac{p^2}{4}\right)}$.

Ex. 2. Let $x^2-12x+35=0$; to find x. By transposition, $x^2-12x=-35$, and adding the square of 6 to both sides of the equation,

$x^2-12x+36=36-35=1$;

then extracting the square root on both sides,

$x-6=\pm 1$

$x=6\pm 1=7$ or 5; either of which, substituted for x in the original equation, answers the condition, that is, makes the whole equal to nothing.

Ex. 3. Let $x+\sqrt{(5x+10)}=8$; to find x.

By transposition, $\sqrt{(5x+10)}=8-x$
squar. both sides $5x+10=64-16x+x^2$

$$x^2-21x=10-64=-54$$

complete the sq. $x^2-21x+\frac{441}{4}=\frac{441}{4}-54$

$=\frac{441-216}{4}$, or $x^2-21x+\frac{441}{4}=\frac{225}{4}$

extracting the sq. root, $x-\frac{21}{2}=\pm\frac{15}{2}$

$$x=\frac{21\pm 15}{2}=3 \text{ or } 18.$$

By this process two values of x are found, but on trial it appears, that 18 does not answer the condition of the equation, if we suppose that $\sqrt{(5x+10)}$ represents the positive square root of $5x+10$. The reason is, that $5x+10$ is the square of $-\sqrt{(5x+10)}$ as well as of $+\sqrt{(5x+10)}$; thus by squaring both sides of the equation $\sqrt{(5x+10)}=8-x$, a new condition is introduced, and a new value of the unknown quantity corresponding to it, which had no place before. Here, 18 is the value which corresponds to the supposition that $x-\sqrt{(5x+10)}=8$.

Every equation, where the unknown quantity is found in two terms, and its index in one is twice as great as in the other, may be resolved in the same manner.

Ex. 4. Let $z+4z^{\frac{1}{2}}=21$

$$z+4z^{\frac{1}{2}}+4=21+4=25$$
$$z^{\frac{1}{2}}+2=\pm 5$$
$$z^{\frac{1}{2}}=\pm 5-2=3, \text{ or } -7$$

therefore $z=9$, or 49.

Ex. 5. Let $y^4-6y^2-27=0$.

$$y^4-6y^2=27$$
$$y^4-6y^2+9=27+9=36$$
$$y^2-3y=\pm 6$$
$$y^2-3\pm 6=9, \text{ or } -3$$
$$y=\pm 3, \text{ or } \pm\sqrt{-3}.$$

Ex. 6 Let. $y^6+ry^3+\frac{q^3}{27}=0$.

$$y^6+ry^3=-\frac{q^3}{27}$$
$$y^6+ry^3+\frac{r^2}{4}=\frac{r^2}{4}-\frac{q^3}{27}$$
$$y^3+\frac{r}{2}=\pm\sqrt{\left(\frac{r^2}{4}-\frac{q^3}{27}\right)}.$$
$$y^3=-\frac{r}{2}\pm\sqrt{\left(\frac{r^2}{4}-\frac{q^3}{27}\right)}.$$
$$y=\sqrt[3]{\left[-\frac{r}{2}\pm\sqrt{\left(\frac{r^2}{4}-\frac{q^3}{27}\right)}\right]}.$$

When there are more equations and unknown quantities than one, a single equation, involving only one of the unknown quantities, may sometimes be obtained by the rules laid down for the solution of simple equations; and one of the unknown quantities being discovered, the others may be obtained by substituting its value in the preceding equations.

Ex.7. Let $\left\{\begin{array}{l} x^2+y^2=65 \\ xy=28 \end{array}\right\}$ To find x and y.

From the second equation, $2xy=56$
& adding this to the 1st, $x^2+2xy+y^2=121$
sub. it from the same, $x^2-2xy+y^2=9$
by extracting the sq. roots, $x+y=\pm 11$

$$\text{and } x-y=\pm 3$$
$$\text{therefore, } 2x=\pm 14$$
$$x=7, \text{ or } -7$$
$$\text{and } y=4, \text{ or } -4$$

PROBLEMS PRODUCING QAUDRATIC EQUATIONS.

Prob. 1. To divide a line of 20 inches into two such parts, that the rectangle under the whole and one part may be equal to the square of the other.

Let x be the greater part, then will $20-x$ be the less.
and $x^2=(20-x).20=400-20x$ by the question.
$x^2+20x=400$
$x^2+20x+100=400+100=500$
$x+10=\pm\sqrt{500}$
$x=+\sqrt{500}-10$, or $-\sqrt{500}-10$.

Prob. 2. To find two numbers, whose sum, product, and the sum of whose squares, are equal to each other.

Let $x+y$ and $x-y$ be the numbers;

their sum is $2x$

their product x^2-y^2

the sum of their sqs. $2x^2=2y^2$
and by the question $2x=2x^2+2y^2$

$$\text{or } x=x^2+y^2$$
$$\text{also, } 2x=x^2-y^2$$
$$\text{therefore, } 3x=2x^2$$

$$x=\frac{3}{2}$$
$$2x=x^2-y^2$$
$$\text{or } 3=\frac{9}{4}-y^2$$
$$y^2=\frac{9}{4}-3=\frac{9-12}{4}=\frac{-3}{4}$$
$$y=\pm\frac{\sqrt{-3}}{2}$$
$$x+y=\frac{3+\sqrt{-3}}{2}$$
$$x-y=\frac{3-\sqrt{-3}}{2}$$

Since the square of every quantity is positive, a negative quantity has no square root; the conclusion therefore shews that there are no such numbers as the question supposes. See BINOMIAL THEOREM; EQUATIONS, *nature of;* SERIES, SURDS, &c. &c.

ALGEBRA, *application of to geometry.*—The first and principal applications of algebra were to arithmetical questions and computations, as being the first and most useful science in all the concerns of human life. Afterwards algebra was applied to geometry, and all the other sciences in their turn. The application of algebra to geometry is of two kinds; that which regards the plane or common geometry, and that which respects the higher geometry, or the nature of curve lines.

The first of these, or the application of algebra to common geometry, is concerned in the algebraical solution of geometrical problems, and finding out theorems in geometrical figures, by means of algebraical investigations or demonstrations. This kind of application has been made from the time of the most early writers on algebra, as Diophantus, Cardan, &c. &c. down to the present times. Some of the best precepts and exercises of this kind of application are to be met with in Sir I. Newton's "Universal Arithmetic," and in Thomas Simpson's "Algebra and Select Exercises." Geometrical problems are commonly resolved more directly and easily by algebra, than by the geometrical analysis, especially by young beginners; but then the synthesis, or construction and demonstration, is most elegant as deduced from the latter method. Now it commonly happens, that the algebraical solution succeeds best in such problems as respect the sides and other lines in geometrical figures; and, on the contrary, those problems in which angles are concerned are best effected by the geometrical analysis. Sir Isaac Newton gives these, among many other remarks on this branch. Having any problem proposed, compare together the quantities concerned in it; and making no difference between the known and unknown quantities, consider how they depend, or are related to, one another; that we may perceive what quantities, if they are assumed, will, by proceeding synthetically, give the rest, and that in the simplest manner. And in this comparison, the geometrical figure is to be feigned and constructed at random, as if all the parts were actually known or given, and any other lines drawn, that may appear to conduce to the easier and simpler solution of the problem. Having considered the method of computation, and drawn out the scheme, names are then to be given to the quantities entering into the computation, that is, to some few of them, both known and unknown, from which the rest may most naturally and simply be derived or expressed, by means of the geometrical properties of figures, till an equation be obtained, by which the value of the unknown quantity may be derived by the ordinary methods of reduction of equations, when only one unknown quantity is in the notation; or till as many equations are obtained as there are unknown letters in the notation.

For example: suppose it were required to inscribe a square in a given triangle. Let ABC, (Plate Miscellanies. fig. 1.) be the given triangle: and feign DEFG to be the required square: also draw the perpendicular BP of the triangle, which will be given, as well as all the sides of it. Then, considering that the triangles BAC, BEF are similar, it will be proper to make the notation as follows, viz. making the base $AC=b$, the perpendicular $BP=p$, and the side of the square DE or $EF=x$, Hence then $BQ=BP-ED=p-x$; consequently, by the proportionality of the parts of those two similar triangles, viz. BP : AC :: BQ : EF, it is $p:b::p-x:x$; then, multiply extremes and means, &c. there arises $px=bp-bx$, or $bx+px=bp$, and $x=\frac{bp}{b+p}$, the side of the square sought; that is, a fourth proportional to the base and perpendicular, and the sum of the two, taking this sum for the first term, or AC+BP : BP :: AC : EF.

The other branch of the application of algebra to geometry was introduced by Descartes, in his Geometry, which is the new, or higher, geometry, and respects the nature and properties of curve lines. In this branch, the nature of the curve is expressed or denoted by an algebraic equation, which is thus derived: A line is

conceived to be drawn, as the diameter or some other principal line about the curve; and upon any indefinite points of this line other lines are erected perpendicularly, which are called ordinates, whilst the parts of the first line cut off by them are called abscisses. Then, calling any absciss x, and its corresponding ordinate y, by means of the known nature, or relations, of the other lines in the curve, an equation is derived, involving x and y, with other given quantities in it. Hence, as x and y are common to every point in the primary line, that equation, so derived will belong to every position or value of the absciss and ordinate, and so is properly considered as expressing the nature of the curve in all points of it; and is commonly called the equation of the curve.

In this way it is found, that any curve line has a peculiar form of equation belonging to it, and which is different from that of every other curve, either as to the number of the terms, the powers of the unknown letters x and y, or the signs or co-efficients of the terms of the equation. Thus, if the curve line HK, (fig. 2.) be a circle, of which HI is part of the diameter, and IK a perpendicular ordinate; then put $HI = x$, $IK = y$, and $p =$ the diameter of the circle, the equation of the circle will be $px - x^2 = y^2$. But if HK be an ellipse, an hyperbola, or parabola, the equation of the curve will be different, and for all the four curves will be respectively as follows: viz.

For the circle . . . $px - x^2 = y^2$,

For the ellipse. . . $px - \frac{p}{t}x^2 = y^2$,

For the hyperbola $px + \frac{p}{t}x^2 = y^2$,

For the parabola . . $px \quad - - = y^2$;

where t is the transverse axis, and p its parameter. And in like manner for other curves.

This way of expressing the nature of curve lines, by algebraic equations, has given occasion to the greatest improvement and extension of the geometry of curve lines; for thus all the properties of algebraic equations, and their roots, are transferred and added to the curve lines, whose abscisses and ordinates have similar properties. Indeed the benefit of this sort of application is mutual and reciprocal, the known properties of equations being transferred to the curves they represent; and, on the contrary, the known properties of curves transferred to their representative equations.

Besides the use and application of the higher geometry, namely of curve lines, to detecting the nature and roots of equations, and to the finding the values of those roots by the geometrical construction of curve lines, even common geometry made be made subservient to the purposes of algebra. Thus, to take a very plain and simple instance, if it were required to square the binomial $a + b$ (fig. 3.) by forming a square, as in the figure, whose side is equal to $a+b$, or the two lines or parts added together denoted by the letters a and b: and then drawing two lines parallel to the sides, from the points where the two parts join, it will be immediately evident that the whole square of the compound quantity $a+b^2$ is equal to the squares of both the parts, together with two rectangles under the two parts, or a^2 and b^2 and $2\,a\,b$, that is, the square of $a+b$ is equal to $a^2+b^2+2\,a\,b$, as derived from a geometrical figure or construction. And in this very manner it was, that the Arabians, and the early European writers on algebra, derived and demonstrated the common rule for resolving compound quadratic equations. And thus also, in a similar way, it was, that Tartalea and Cardan derived and demonstrated all the rules for the resolution of cubic equations, using cubes and parallelopipedons instead of squares and rectangles. Many other instances might be given of the use and application of geometry in algebra.

ALGOL, the name of a fixed star of the third magnitude in the constellation Perseus, otherwise called *Medusa's Head.* This star has been subject to singular variations, appearing at different times of different magnitudes, from the fourth to the second, which is its usual appearance. These variations have been noticed with great accuracy, and the period of their return is determined to be $2^d\ 20^h\ 48'\ 56''$. The cause of this variation, Mr. Goodricke, who has attended closely to the subject, conjectures, may be either owing to the interposition of a large body revolving round Algol, or to some motion of its own, in consequence of which, part of its body, covered with spots or some such like matter, is periodically turned towards the earth.

ALGORITHM, an Arabic term, not unfrequently used to denote the practical rules of algebra, and sometimes for the practice of common arithmetic; in which last sense it coincides with *logistica nume-*

ralis, or the art of numbering truly and readily.

ALIEN, in law, a person born in a strange country, not within the king's allegiance, in contradistinction from a denizen or natural subject.

An alien is incapable of inheriting lands in England, till naturalized by an act of parliament. No alien is entitled to vote in the choice of members of parliament, has a right to enjoy offices, or can be returned on any jury, unless where an alien is party in a cause; and then the inquest of jurors shall be one half denizens and the other aliens.

Every alien neglecting the king's proclamation, directing him to depart from the realm within a limited time, shall, on conviction, for the first offence, be imprisoned for any time not exceeding one month, and not exceeding twelve months for the second; at the expiration of which, he shall depart within a time to be limited: and if such alien be found therein after such time so limited, he or she shall be transported for life.

ALIMENTARY *duct*, a name which some call the intestines, on account of the food's passing through them. See ANATOMY.

ALIMONY, *alimonia*, in law, denotes the maintenance sued for by a wife, in case of a separation from her husband, wherein she is neither chargeable with elopement nor adultery.

ALIQUANT *parts*, in arithmetic, those which will not divide or measure the whole number exactly. Thus, 7 is an aliquant part of 16, for twice 7 wants 2 of 16, and three times 7 exceeds 16 by 5.

ALIQUOT *part*, is such part of a number as will divide and measure it exactly, without any remainder. For instance, 2 is an aliquot part of 4, 3 of 9, and 4 of 16.

To find all the aliquot parts of a number, divide it by its least divisor, and the quotient by its least divisor, until you get a quotient not farther divisible, and you will have all the prime divisors or aliquot parts of that number. Thus, 60, divided by 2, gives the quotient 30, which divided by 2 gives 15, and 15 divided by 3 gives the indivisible quotient 5. Hence, the prime aliquot parts are 1, 2, 2, 3, 5; and by multiplying any two or three of these together, you will find the compound aliquot parts, viz. 4, 6, 10, 12, 15, 20, 30.

Aliquot parts must not be confounded with commensurable ones; for though the former be all commensurable, yet these are not always aliquot parts: thus 4 is commensurable with 6, but is not an aliquot part of it.

ALISMA, *great water plantain*, in botany, a genus of the Hexandria Polyginia class of plants, the calyx of which is a perianthium composed of three oval, hollow, permanent leaves; the corolla consists of three large, roundish, plane, and very patent petals; the fruit consists of capsules, arranged together in a roundish or trigonal form: the seeds are single and small. There are nine species.

ALKAHEST, or ALCAHEST, among chemists, denotes a universal menstruum, capable of resolving all bodies into their *ens primum*, or first matter; and that without suffering any change, or diminution of force, by so doing. See ALCHEMY.

ALKALI, in chemistry, a word applied to all bodies that possess the following properties: they change vegetable blue colours, as that of an infusion of violets, to green: they have an acrid and peculiar taste: they serve as intermedia between oils and water: they are capable of combining with acids, and of destroying their acidity: they corrode woollen cloth, and, if the solution be sufficiently strong, reduce it to jelly; and they are soluble in water. The alkalies at present known are three; viz. ammonia, potash, and soda: the two last are called *fixed* alkalies, because they require a red heat to volatilize them; the other is denominated *volatile* alkali, because it readily assumes a gaseous form, and is dissipated by a very moderate degree of heat. Barytes, strontian, lime, and magnesia, have been denominated alkalies by Fourcroy; but as they possess the striking character of earths in their fixity, this innovation does not seem entitled to general adoption.

Since writing the above, some discoveries of great importance, on the subject of alkalies, have been made known to the philosophical world by Mr. Davy, Professor of Chemistry at the Royal Institution. We shall in this place give a sketch of the two papers which he has just laid before the Royal Society, referring to some subsequent articles for further particulars. In a former discourse, read before this learned body, Mr. Davy, in speaking of the agencies of electricity, suggested the probability, that other bodies not then enumerated might be decomposed by the electric fluid. In the course of the last summer, this celebrated philosopher was employed in making a number of experiments with this particular view, and by means of very powerful galvanic troughs, consisting of a

hundred pair of plates, six inches square, and one hundred and fifty pair, four inches square, he has succeeded in decomposing potash and soda. A more brilliant discovery has not been made since those which have immortalized the names of Priestley and Cavendish. This was effected by placing moistened potash, or soda, on a plate of platina, and exposing it to the galvanic circle. Oxygen was disengaged, and the alkalies reduced to their primitive base, which is found to be a peculiar and highly inflammable matter, and which assumes the form and appearance of small globules of mercury. These globules are, however, lighter than water, and when potash is used, they are in the proportion of 6 to 10. At the freezing point they are hard and brittle; and when broken and examined by a microscope, they present a number of facettes with the appearance of crystallization: at 40° Fahrenheit they are soft, and can scarcely be discriminated but by their gravity from globules of mercury; at 60° they are fluid, and at the small heat of 100° volatile. When exposed to the atmosphere, they rapidly imbibe oxygen, and reassume the alkaline character. In distilled naptha they may be preserved four or five days, but if exposed to the atmosphere, they almost instantly become incrusted with a coat of alkali: the incrustation may be removed, and the reduced globule will remain, either in naptha, or otherwise separated from all contact with oxygen. See BITUMEN.

One part of the base of alkali and two of mercury, estimated by bulk, form an amalgam, which when applied in the circle of a galvanic battery, producing an intense heat to iron, silver, gold, or platina, immediately dissolved them, and converted them into oxides, in which process alkali was regenerated. Glass, as well as all other metallic bodies, was also dissolved by the application of this substance: the base of the alkali seizing the oxygen of the manganese and of the minium, potash was regenerated. One of these globules placed on a piece of ice dissolved it, and burnt with a bright flame, giving out an intense heat. Potash was found in the product of the dissolved ice. Nearly the same effects followed, when a globule was thrown into water: in both cases a great quantity of hydrogen was rapidly liberated. When laid on a piece of moistened turmeric paper, the globule seemed instantly to acquire an intense heat; but so rapid was its movement in quest of the moisture, that no part of the paper was burnt, only an intense deep red stain marked the course it followed, and showed a reproduction of alkali. The specific gravity of the base of soda is as seven to ten of water: it is fixed in a temperature of about 150°, and fluid at 180°. Mr Davy next tried its effects on the phosphates, phosphurets, and many other salts of the first and second degree of oxydizement, all of which it decomposed, seizing their oxygen, and reassuming its alkaline qualities. From many experiments it appears, that 100 parts of potash contain 15 of oxygen, and 85 of an inflammable base, and that the same quantity of soda contains 20 of oxygen, and 80 base This ingenious chemist, after a great number of complex experiments, in which he was assisted by Messrs. Pepys and Allen, ascertained that oxygen is also an essential ingredient in ammonia; of which 100 grains appeared to yield 20 of oxygen. Mr. Davy has also found that oxygen is one of the constituent principles of the earths barytes and strontites. See CHEMISTRY, POTASH, and SODA.

ALLAMANDA, in botany, a genus of the Pentandria Monogynia class and order: corolla twisted; capsule lens-form, erect, echinate, one-celled, two-valved, many-seeded. One species, viz. cathartica, a climbing plant, found in Guiana, near rivers. The infusion of its leaves is used in the cholic.

ALLANTOIS, or ALLANTOIDES, in comparative anatomy, a vesicle investing the fœtus of several animals, as cows, sheep, goats, &c. and filled with a urinous liquor conveyed thither from the urachus.

ALLEGIANCE, is the lawful duty from the subject to the sovereign; and is either natural, as every subject born ought to pay; acquired, where a man is naturalized; local, which a man ought to pay who comes under the dominion of the king.

ALLEGORY, in matters of literature, a mode or species of writing, wherein something else is signified than the words in their literal meaning express. An allegory may be considered as a series or chain of metaphors, continued through a whole discourse For example, when the prophets represent the Jews under the allegory of a vine planted, cultivated, and watered, by the hand of God, which, instead of producing good fruit, brings forth verjuice and sour grapes.

ALLEGRO, in music, an Italian word, denoting that the part is to be played in a sprightly, brisk, lively, and gay manner. Allegros move swifter in triple than in

common time. Sometimes in conjunction with another word, placed at the beginning of compositions, it is intended to rouse and stimulate the more violent passions.

ALLEMANDE, in music, a slow air or melody in common time, of four crotchets in a bar. A species of composition, supposed from its name to be of German origin. It is found in Handel's harpsichord lessons, and other works of about that date; but as a sonata movement it is now obsolete. The dance known by this name is still used in Germany and Switzerland, and is written in common time of two crotchets in a bar.

ALLEN, (Thomas,) a celebrated mathematician of the 16th century. He was born at Uttoxeter in Staffordshire, in 1542; was admitted a scholar of Trinity College, Oxford, in 1561; where he took his degree of master of arts in 1567. In 1570 he quitted his college and fellowship, and retired to Gloucester Hall, where he studied very closely, and became famous for his knowledge in antiquities, philosophy, and mathematics. He received an invitation from Henry, Earl of Northumberland, a great friend and patron of the mathematicians, and he spent some time at the Earl's house, where he became acquainted with those celebrated mathematicians, Thomas Harriot, John Dee, Walter Warner, and Nathaniel Torporley. Robert, Earl of Leicester, too, had a great esteem for Allen, and would have conferred a bishopric upon him; but his love for solitude and retirement made him decline the offer. His great skill in the mathematics, gave occasion to the ignorant and vulgar to look upon him as a magician or conjurer. Allen was very curious and indefatigable in collecting scattered manuscripts relating to history, antiquity, astronomy, philosophy, and mathematics; which collections have been quoted by several learned authors, and mentioned as in the Bibliotheca Alleniana. He published in Latin the second and third books of Ptolemy, "Concerning the Judgment of the Stars," or, as it is usually called, of the quadripartite construction, with an exposition. He wrote also notes on many of Lilly's books, and some on John Bale's work, "De Scriptoribus Mag. Brittanniæ." He died at Gloucester Hall in 1632, being 90 years of age.

Mr. Burton, the author of his funeral oration, calls him "the very soul and sun of all the mathematicians of his age." And Selden mentions him as a person of the most extensive learning and consummate judgment, the brightest ornament of the University of Oxford. Also Camden says, he was skilled in most of the best arts and sciences. A. Wood has also transcribed part of his character from a manuscript in the library of Trinity College, in these words: "He studied polite literature with great application; he was strictly tenacious of academic discipline, always highly esteemed both by foreigners and those of the university, and by all of the highest stations of the church of England, and the University of Oxford. He was a sagacious observer, an agreeable companion," &c.

ALLIGATION, in arithmetic, is the rule of mixture, which teaches to compound several species of ingredients or commodities together, according to any intent or design proposed; and is either medial or alternate.

Alligation, *medial*, shews the rate or price of any mixtures, when the several quantities of the mixture, and their rates, are known.

Rule: multiply each quantity given by the price; and then, by direct proportion, say, as the sum of the quantities given to the sum of the products; so is any part of the mixture to the value of that part. Example: a goldsmith melts 3 ounces of gold, at 4*l.* 6*s.* 8*d.* per ounce, with twelve ounces at 4*l.* per ounce; and 8 ounces at 4*l.* 5*s.* per ounce: when they are all melted together, one ounce will be found to be worth 4*l.* 2*s.* $\frac{7}{23}$*d.* Thus,

oz.		l. s. d.		l.
3	at	4 6 8	multiplied together produce	13
12		4 0 0		48
8		4 5 0		34
23 Sum			Sum	95

Then as 23 : 95 :: 1 : 4 2 $7\frac{7}{23}$ Ans. (oz. l. : oz. l. s. d.)

Alligation, *alternate*, teaches to mix goods, of different prices, in such proportion, that the mixture may be sold for any price proposed.

Rule: set down the names of the things to be mixed, together with their prices; then, finding the difference between each of these, and the proposed price of the mixture, place these differences in an alternate order, and they will show the proportion of the ingredients.

ALLIONIA, in botany, so called in honour of Charles Allioni, professor of botany at Turin, a genus of the Tetrandria Monogynia class and order, of the natural order of Aggregatæ; the calyx is a perianthium common to three flowers; and the perianthium proper is obsolete supe-

rior; the corolla proper, one-petalled, funnel-shaped, and erect; the stamina have setaceous filaments; anthers roundish; the pistillum has a germ inferior, oblong, style setaceous, longer than the stamens, stigma multifid and linear, no pericarpium; seeds solitary, the receptacle naked. There are two foreign species, described by Willdenow, viz. the A. violacea, and A. incarnata. The American species described by Pursh are three in number, viz. A. nyctaginea, A. albida, and A. ovata. The first is found on the banks of the river Tenessee; the second in lower Carolina; the third found by Meriwether Lewis on the plains of the Missouri.

ALLIOTH, a star in the tail of the Greater Bear, much used for finding the latitude at sea.

ALLITERATION, in rhetoric, is a figure, or decoration in language, chiefly used in poetry, and consisting in the repetition of the same letter or letters at certain intervals, whence the name is derived.

ALLIUM, *garlic*, in botany, a genus of the Hexandria Monogynia class and order; the calyx is a common sheath, and many-flowered; the corolla consists of six oblong petals; the stamina have six filaments, generally of the length of the corolla; the anthers are oblong and upright; the pistillum has a germ, superior, short, bluntly three-cornered; the pericarpium is a capsule, short, broad, three-celled and three-valved; the seeds are many and round. There are 53 species, according to Willdenow, distributed into several divisions. The common garlic has a large round white bulbous root, of an irregular form, with numerous fibres at the bottom, composed of many smaller bulbs denominated cloves, which are included in a common membranous covering, each of which being planted, grows, and in one season attains the size and structure of the parent bulb; the leaves are cauline, or form a kind of stalk, which seldom spindles, except when the same roots remain in the ground two or three years, when they run up and bear a flower and small bulbs at the top. It deserves to be cultivated in the garden for the sake of its root, which is in great estimation for culinary and other domestic purposes. Indeed, the roots, as well as all the other parts of the plant, have a very acrid taste, with an highly offensive smell, which has rendered its cultivation in gardens less desirable. It is a hardy plant, capable of growing in most sorts of soils and situations, and readily propagated either by roots or seeds.

Rocambole has very small compound bulbs, which grow in clusters; the stalk generally spindling two or three feet high, with many bulbs at its summit, which, as well as the root bulbs, are useful for the same purposes as garlic, though much inferior. The latter, or the flowery kinds, have the flower-stems rising immediately from the root, growing erect, and attaining different heights, from twelve to thirty inches; in some the leaves are radical, in others cauline, or elevated with the stalk; some are broad like those of a tulip, others long and narrow like a daffodil, and some taper and rush-like; but in all the sorts the stems are terminated by a sort of sheath, from which is protruded an aggregate of many small flowers, forming a kind of umbel. The flowers singly are composed each of six petals, which, though separately small, from many being collected into large heads, are very conspicuous. Of the second division, or the onion kind, the characters, &c. of which are the same as those of garlic, the species are these: 1. Cepa, or common onion; the best garden varieties of which are, the Strasburgh or common round onion, the oval or long-keeping common onion, the Spanish large flat onion, the Spanish silken-skinned onion, the Spanish red-skinned onion, and the Portugal great roundish oval onion. 2. Fistulosum, or the ciboule or Welsh onion. 3. Schænoprasum, cives or chives. 4. Ascalonicum, eschalot or schallot. 5. Canadense, or Canada-tree onion. All the first species and varieties have large bulbous roots, and the plants are biennial, or, being sown in the spring, arrive at perfection in the root the same year, and next year shoot up into stalk, flower, and ripen seed, when the stalks quickly die, and the individuals are annihilated. But the second and third species never form any bulbs at bottom; they are, however, hardy and perennial, and may be continued many years. And the fourth and fifth species are bulbous rooted perennials, multiplying greatly by off-sets, as is evident from their culture.

Ciboule or Welsh onion. This is a perennial plant, which never forms any bulb at bottom; therefore deserves to be cultivated only to be drawn as young green onions for salads, &c. in spring; but, on account of its strong taste, it is greatly inferior to those of the common onion. From the plants being so extremely hardy as to survive the severest winter, in

which, though their blades be cut off, the roots remain sound, and shoot forth with great vigour early in spring, furnishing seasonable supplies till May, when they generally run to seed. From this singular hardness they may be cultivated more or less as a winter standing crop, with advantage, for spring use.

Cives, or chives. This is the smallest of all the onion kind, rising but a few inches high; but its roots are perennial, and increase considerably into clusters, from which large tufts of slender awl-shaped leaves issue, which are the principal part used, the roots never forming any bulb, at least not bigger than small peas. This is a hardy plant, which merits a place in every garden. Its clusters of leaves rise early in spring, and are useful both in salads and for culinary purposes, in default of onions. The method of gathering it is, to cut the leaves off near the ground, by which a fresh supply is soon produced from the bottom; or occasionally the plants in clusters may be slipped quite to the root in separate little plants, resembling young onions, and used as substitutes for them. It is easily increased by dividing the roots in spring, and planting eight or ten of them together in holes, at six inches distance; in this way, by autumn, they will multiply into bunches of a large size.

Eschalot, or schallot. This is a species of onion which is bulbous-rooted, and which increases greatly by off-sets, the largest of which are the proper parts of the plant for use. The bulbs are oblong, irregular, and seldom grow large; as they generally increase into clusters, they do not swell like roots that grow singly. From the roots are produced many long, narrow, infirm leaves in the spring, and which wither in July or August, when the roots are full grown: they are then taken up, made dry, and housed, when they keep in good perfection till the following spring.

Canada or tree-onion. This deserves to be cultivated, both as a curiosity in producing the onion at the top of the stalk, and for the use of the onions, especially for pickling, in which they are excellent, and superior in flavour to the common onion. It is perennial, and propagated by planting the bulbs in spring or autumn. Either the root-bulbs, or those produced on the top of the stalk, being planted in a bed or beds of any good earth, in rows a foot asunder, six inches distance in each row, and two or three inches deep, they shoot up leaves and stalks in the spring and summer, and produce the bulbs for use in July or August; and the root-bulbs remaining furnish a production of top-bulbs, annually, in that season; the root-bulb increasing by off-sets, may be taken up occasionally at the time the stem decays in autumn; or once in two or three years, in order to separate the off-sets, and replant them when necessary.

The leek is the third division of the genus, the general characters of which are the same as those before described, and the species and varieties are, the porrum, or common leek, which may be said to be an annual-biennial plant; for although the roots often survive after perfecting seeds, yet the plants always attain perfection the same year they are sown, and the year afterwards run up to stalk, and become unfit for use. The seed-stalk of this plant does not belly like that of the onion. The best of the varieties of this plant for general culture is the broad-leaved or London leek, which attains a large growth, the neck acquiring a thick substance, in length from six to nine or ten inches, dividing upwards into many large, long, thick leaves, arranging themselves in somewhat of a fan-shape. There are seven species indigenous in America, and described by Pursh, viz: 1. A. vineale, common in old fields. 2. A. fragrans, (which is A. inodorum of Botanical Magazine 1129, and A. mutabile of Michaux's fl. Ame. 1 p. 195) found on the mountains of Virginia and Carolina. 3. A. striatum (which is A. ornithogaloides of Halt's fl. Car. 121, and ornithogalum bivalve of Lin.) native in Virginia and Carolina. 4. A. angulosum, found on the banks of the Missouri by Lewis and Nuttall. 5. A. triflorum, found on shady woods and high mountains of Pennsylvania. 6. A. canadense, found in fields and woods from Canada to Carolina. 7. A. tricoccon, found in shady woods, Pennsylvania to Virginia.

ALLODIAL, an epithet given to an inheritance held without any acknowledgment to a lord or superior, in opposition to feudal.

ALLODIUM, or ALLEUD, denotes lands which are the absolute property of their owner, without being obliged to pay any service or acknowledgment whatever to a superior lord; in which sense they stand opposed to feudal lands, which pay a fee to some superior.

ALLOPHYLUS, in botany, a genus of the Octandria Monogynia class of plants, the calyx of which is a perianthium composed of four leaves of an orbicular figure,

and two opposite ones smaller than the others; the corolla consists of four petals, less than the cup, of an orbicular figure, and equal one to another, with large ungues of the same length with the smaller leaves of the cup. There are three species: A. zeylanicus is a tree having the appearance of persea, and a native of Ceylon. A. cominia rises 30 feet in height, with a stem as thick as a man's thigh, with numerous flowers, to which succeed berries the size of a pin's head, with shell and kernel: grows plentifully in Jamaica. A. ternatus is a native of Cochin China.

ALLOY, or Allay, a proportion of a baser metal mixed with a finer one. Thus, all gold coin has an alloy of silver and copper, as silver coin has of copper alone; the proportion in the former case, for standard gold, being two carats of alloy in a pound troy of gold; and in the latter, 18 penny-weights of alloy for a pound troy of silver.

According as gold or silver has more or less alloy than that mentioned above, it is said to be coarser or finer than the standard. However, it ought to be remarked, that the coin of different nations varies greatly in this respect; some using a larger, and others a less proportion of alloy, the original intention of which was to give the coin a due degree of hardness.

Alloy, in a chemical sense, may be defined a combination of two or more metals into one homogeneous mass, not separable from each other by mere heat. The most valuable and useful of these are, brass, type-metal, tutenag, bronze, speculum metal, for which see the different articles. If two metals being fused together produce a mass, whose specific gravity is either greater or less than the mean specific gravity of its elements, the result is an alloy, or proper chemical combination. One of the most striking proofs of actual combination between the parts of an alloy is, a remarkable increase of fusibility. This, in almost all cases, is much greater than could be inferred from the mean fusibility of its component parts. Thus, equal parts of tin and iron will melt at the same temperature as is required for equal parts of tin and copper, notwithstanding the great difference between the fusing heat of copper and iron, when they are each of them pure. So also an alloy of tin, bismuth, and lead, in the proportion of 3, 8, and 5, will melt in boiling water, which is a less heat than is necessary for the liquefaction of bismuth, the most fusible of the three. The oxydability of an alloy is generally either greater or less than that of the unmixed metals. Tin and lead mixed will, at a low red heat, take fire, and oxydate immediately.

ALLUSION, in rhetoric, a figure by which something is applied to, or understood of another, on account of some similitude between them.

ALLUVIAL, by alluvial depositions is meant the soil which has been formed by the destruction of mountains, and the washing down of their particles by torrents of water. The alluvial formations constitute the great mass of the earth's surface. They have been formed by the gradual action of rain or river water upon the other formations. They may be divided into two kinds, viz. those deposited in the vallies and mountainous districts, or upon elevated plains, which often occur in mountains; and those deposited upon flat land. The first kind consists of sand, gravel, &c. which constituted the more solid parts of the neighbouring mountains, and which remained when the less solid parts have been washed away. They sometimes contain ores, particularly gold and tin, which existed in the neighbouring mountains. The second kind consists of loam, clay, sand, turf, and calctuff. Here are also earth and brown coal, in which amber is found, wood coal, bituminous wood, and bog-iron ore. The sand contains some metals. The calctuff contains plants, roots, moss, bones, &c. which it has incrusted. The clay and sand often contain petrified wood, and skeletons of quadrupeds.

ALLUVION, among civilians, denotes the gradual increase of land along the sea-shore, or on the banks of rivers. This, when slow and imperceptible, is deemed a lawful means of acquisition: but when a considerable portion of land is torn away at once by the violence of the current, and joined to a neighbouring estate, it may be claimed again by the former owner.

ALMAGEST, the name of a celebrated book composed by Ptolemy; being a collection of a great number of the observations and problems of the ancients, relating to geometry and astronomy, but especially the latter; and being the first work of this kind which has come down to us, and containing a catalogue of the fixed stars, with their places, besides numerous records and observations of eclipses, the motions of the planets, &c. it will ever be held dear and valuable to the cultivators of astronomy. See Ptolemy.

In the original Greek it is called *συνταξις μεγιςη*, the "great composition" or "collection." And to the word

μεγιςη the Arabians joined the particle "al," and thence called it "Almaghesti," or, as we call it from them, the Almagest.

ALMAMON, Caliph of Bagdat, a philosopher and astronomer in the beginning of the ninth century, he having ascended the throne in the year 814. He was son of Harun Al-Raschid, and grandson of Almansor. Having been educated with great care, and with a love for the liberal sciences, he applied himself to cultivate and encourage them in his own country. For this purpose he requested, the Greek emperors to supply him with such books of philosophy as they had among them; and he collected skilful interpreters to translate them into the Arabic language. He also encouraged his subjects to study them; frequenting the meetings of the learned, and assisting at their exercises and deliberations. He formed a college at Khorasan, and selected to preside over it Mesul of Damascus, a famous Christian physician. When his father, who was still living, remonstrated against the appointment, on account of the president's religion, he replied, that he had chosen him, not as a teacher of theology, but for the instruction of his subjects in science and the useful arts, and that his father well knew, that the most learned men and skilful artists in his dominions were Jews and Christians. He caused Ptolemy's Almagest to be translated in 827, by Isaac Ben-honain, and Thabet Ben-korah, according to Herbelot, but according to others, by Sergius, and Alhazen, the son of Joseph. In his reign, and doubtless by his encouragement, an astronomer of Bagdat, named Habash, composed three sets of astronomical tables.

Almamon himself made many astronomical observations, and determined the obliquity of the ecliptic to be then 23° 35′, or 23° 33′ in some manuscripts, but Vossius says 23° 51′, or 23° 34′. He also caused skilful observers to procure proper instruments to be made, and to exercise themselves in astronomical observations; which they did accordingly at Shemasi in the province of Bagdat, and upon Mount Casius, near Damas.

Under the auspices of Mamon, also, a degree of the meridian was measured on the plains of Sinjar, or Sindgiar, upon the borders of the Red Sea; by which the degree was found to contain 56 2-3 miles, of 4000 coudees each, the coudee being a foot and a half: but it is not known what foot is here meant, whether the Roman, the Alexandrian, or some other. Albufeda says that this cubit contained 27 inches, each inch being determined by six grains of barley placed sideways; but Thevenot says, that 144 grains of barley, placed in this manner, would give a length equal to 1½ Paris foot: four cubits would be equal to one toise and nine inches, and therefore 4000 cubits, that is, 56 2-3 miles, would give 63,730 toises. But if the ordinary cubit of 24 inches was the measure to which the calculation is to be referred, the degree, in this estimate of it, would contain 56,666 toises. According to another valuation of a cubit, this measure would consist of 53,123 French toises.

Almamon was a liberal and zealous encourager of science, in consequence of which the Saracens began to acquire a degree of civilization and refinement, to which they had formerly been strangers. The liberality of his mind obtained for Almamon the reputation of infidelity. But, whatever opinions he might hold respecting the Koran, he seems to have had a confidence and trust in the Supreme Being. In this work we shall not follow the Caliph into the field of battle, nor record his victories, which were brilliant and important. We must look to him in the character of a philosopher and man of science, and, in addition to what has already been noticed, we may remark, that he built a new nilometer, for measuring the increase of the Nile, and repaired one that was gone to decay. In the year 833, as he was returning from one of his expeditions, he unwarily quenched his thirst, while very much heated by exercise, with cold water, which brought on a disorder that terminated his life. During his last illness, he settled the affairs of the state, and then exclaiming, in the spirit of piety, "O thou who never diest, have mercy on me, a dying man." He expired at the age of 49, after a reign of 20 years. He was interred at Tarsus. To the principles of science, and not to those of the Mohammedan religion, have been ascribed the liberality and benignity of temper, which he displayed in certain trying circumstances. When his uncle and rival Ibrahim was taken, brought to trial, and condemned, the caliph, instead of sanctioning the sentence, tenderly embraced his relation, saying, "Uncle, be of good cheer, I will do you no injury:" and he not only pardoned him, but granted him a rank and fortune suitable to his birth. Being complimented on account of this generous deed, he exclaimed, "Did but men know the pleasure that I feel in par-

doning, all who have offended me would come and confess their faults." Almamon, in the course of his reign, employed the most skilful astronomers that he could find, to compose a body of astronomical science, which still subsists among oriental MSS. entitled "Astronomia elaborata à compluribus D. D. jussu regis Maimon."

ALMANAC, in matters of literature, a table containing the calendar of days and months, the rising and setting of the sun, the age of the moon, &c.

Authors are neither agreed about the inventor of almanacs, nor the etymology of the word; some deriving it from the Arabic particle *al*, and *manah*, to count; whilst others think it comes from *almanah*, *i. e.* handsels, or new year's gifts, because the astrologers of Arabia used, at the beginning of the year, to make presents of their ephemerides for the year ensuing.

As to the antiquity of Almanacs, Ducange informs us, that the Egyptian astrologers, long before the Arabians, used the term *almenach*, and *almenachica descriptio*, for their monthly predictions. Be this as it will, Regiomontanus is allowed to have been the first who reduced almanacs to their present form.

Almanacs, *construction of*. The first thing to be done is, to compute the sun's and moon's place for each day in the year, or it may be taken from some ephemerides and entered in the almanac; next, find the dominical letter, and, by means thereof, distribute the calendar into weeks: then, having computed the time of Easter, by it fix the other moveable feasts; adding the immoveable ones, with the names of the martyrs, the rising and setting of each luminary, the length of day and night, the aspects of the planets, the phases of the moon, and the sun's entrance into the cardinal points of the elliptic, *i. e.* the two equinoxes and solstices.

These are the principal contents of almanacs; besides which there are others of a political nature, and consequently different in different countries, as the birth-days and coronation of princes, tables of interest, &c.

On the whole, there appears to be no mystery, or even difficulty, in almanac making, provided tables of the heavenly motions be not wanting. For the duties upon almanacs, see Stamp-duties.

Almanac, *nautical and astronomical ephemeris*, is a kind of national almanac, published annually by anticipation, under the direction of the commissioners of longitude. Besides every thing essential to general use that is to be found in other almanacs, it contains, among other particulars, the distances of the moon from the sun and fixed stars for every three hours of apparent time, adapted to the meridian of Greenwich, by comparing which with the distances carefully observed at sea, the mariner may readily infer his longitude, to a degree of exactness that may be thought sufficient for most nautical purposes. The publication of it is chiefly designed to facilitate the use of Mayer's lunar tables, by superseding the necessity of intricate calculations in determining the longitude at sea.

Almanac, is part of the law of England, of which the courts must take notice in the returning of writs; but the almanac to go by is that annexed to the Book of Common Prayer. An almanac, in which the father had written the day of the nativity of his son, was allowed as evidence to prove the nonage of his son.

ALMOND-*tree*, in botany. See Amygdalus.

ALMUCANTARS, in astronomy, an Arabic word denoting circles of the sphere passing through the centre of the sun, or a star, parallel to the horizon, being the same as parallels of altitude.

Almucantars are the same, with respect to the azimuths and horizon, that the parallels of latitude are, with regard to the meridians and equator. They serve to shew the height of the sun and stars, and are described on many quadrants, &c.

ALNAGE, or Aulnage, in the English polity, the measuring of woollen manufactures with an ell, and the other functions of the alnager. See the next article. Alnage was at first intended as a proof of the goodness of the commodity, and therefore a seal was invented, as a signal that the commodity was made according to the statute.

ALNAGER, in the English polity, a public sworn officer, whose business is to examine into the assize of all woollen cloth made throughout the kingdom, and to fix seals upon them. Another branch of his office is, to collect an alnage duty to the king. See the last article.

There are now three officers relating to the alnage, namely, a searcher, measurer, and alnager; all which were formerly comprized in the alnager, until, by his own neglect, it was thought proper to separate these offices.

ALNUS, the *alder-tree*, in botany. See Betula.

ALOE, in botany, a genus of the Hex-

andria Monogynia class of plants, with a liliaceous flower, consisting of only one tubular leaf, divided into six deep segments at the edge; its fruit is an oblong capsule, divided into three cells, and containing a number of angulated seeds. There are 16 species.

Several species of this exotic plant are cultivated in the gardens of the curious, where they afford a very pleasing variety, as well by the odd shape of their leaves, as by the different spots with which they are variegated.

Some aloes are arborescent, or divided into a number of branches, like trees; others are very small, growing close to the ground. The two most considerable species are the aloe of America, and that of Asia; the former on account of its beautiful flowers, and the latter for the drug prepared from it.

All the aloes are natives of hot climates; and the place of growth of most of them is the Cape of Good Hope. The Hottentots hollow out the trunk of the first species, or A. dichotoma, to make quivers for their arrows; and several of them are used for hedges. Among the Mahometans, and particularly in Egypt, the aloe is a kind of symbolic plant, and dedicated to the offices of religion: for pilgrims, on their return from Mecca, suspend it over their doors as an evidence of their having performed that holy journey. The superstitious Egyptians imagine, that it has the virtue of keeping off apparitions and evil spirits from their houses, and it is hung over the doors of Christians and Jews in Cairo for this purpose. They also distil from it a water, which is sold in the shops, and recommended in coughs, asthmas and hysterics. Hasselquist mentions a person who was cured of the jaundice in four days by taking about half a pint of it. The Arabians call it sabbara. The negroes, as we are informed by Adanson, in his voyage to Senegal, make very good ropes of the leaves of the Guinea aloes, which are not apt to rot in water. M. Fabroni, as we learn from the Annales de Chimie, procured from the leaves of the aloe succotrina angustifolia, a violet dye, which resists the action of oxygen, acids, and alkalies. This juice, he says, produces a superb transparent colour, which is highly proper for works in miniature, and which, when dissolved in water, may serve, either cold or warm, for dying silk from the lightest to the darkest shade: and he reckons it one of the most durable colours known in nature. Aloes was used among the ancients in embalming, to preserve bodies from putrefaction. Of this species of aloes, interpreters understand that to have been which Nicodemus brought to embalm the body of Christ, John xix. 3. Aloes, whose resinous part is not soluble in water, has been used as a preservative to ship's bottoms against the worms, to which those that trade to the East and West Indies are particularly subject. One ounce of aloes is sufficient for two superficial feet of plank; about 12lb. for a vessel of 50 tons burthen, and 300 lb. for a first rate man of war. It may be incorporated with six pounds of pitch, one of Spanish brown, or whiting, and a quart of oil; or with the same proportion of turpentine, Spanish brown and tallow. Such a coat, it has been said, will preserve a ship's bottom eight months, and the expense for a first rate ship will be about 18*l.* The same composition may be used in hot countries for preserving rafters, &c. from the wood-ant. The efficacy of aloes, as a defence against worms, has been controverted.

Aloe, or Aloes, in pharmacy, the inspissated juice of the aloe perfoliata, asiatic aloe, prepared in the following manner: from the leaves, fresh pulled, is pressed a juice, the thinner and purer part of which is poured off, and set in the sun to evaporate to a hard yellowish substance, which is called *succotrine aloe*, as being chiefly made at Succotra. The thicker part, being put into another vessel, hardens into a substance of a liver-colour, and thence called *aloe hepatica.* The thickest part, or sediment, hardens into a coarse substance, called *aloe caballina*, or the horse-aloe, as being chiefly used as a purge for horses.

Fabroni has discovered that the recent juice of the leaves of the aloe has the property of absorbing oxygen, of assuming a fine reddish purple, and of yielding a pigment which he strongly recommends to the artist.

ALOPECURUS, *fox-tail-grass*, in botany, a genus of the Triandria Digynia class of plants, and of the natural order of Grasses, the calyx of which is a bivalve glume, containing a single flower; the valves are hollow, of an ovate lanceolated figure, equal in size, and compressed; the corolla is univalve; the valve is concave, and of the length of the cup, and has a very long arista inserted into its back near the base. There is no pericarpium: the corolla itself remains, and contains the seed, which is single and of a roundish figure. There are 12 species. The A. pratensis, meadow foxtail, is a na-

tive of most parts of Europe, and is found with us very common in pastures and meadows. It is perennial, and flowers in May. This is the best grass to be sown in low meadow grounds, or in boggy places which have been drained. It is grateful to cattle, and possesses the three great requisities of quantity, quality, and earliness, in a degree superior to any other, and is therefore highly deserving of cultivation in lands that are proper for it. The seed may be easily collected, as it does not quit the chaff, and the spikes are very prolific; but the larvæ of a species of muscæ, which are themselves the prey of the cimex campestris, devour the seeds so much, that in many spikes scarcely one is found perfect. A. agrestis is a very troublesome weed in cultivated ground, and among wheat it is execrated by farmers, under the name of blackbent; it is also common by way sides, as well as in corn fields, and in pastures in the Isle of Wight. It has acquired the name of mouse-tail grass in English, from the great length and slenderness of the spike, which resembles the tail of a mouse. It is annual, and flowers in July, continues flowering till autumn, and comes into bloom very soon after being sown.

ALPHABET, in matters of literature, the natural or accustomed series of the several letters of a language.

As alphabets were not contrived with design, or according to the just rules of analogy and reason, but have been successively framed and altered, as occasion required, it is not surprising that many grievous complaints have been heard of their deficiencies, and divers attempts made to establish new and more adequate ones in their place

All the alphabets extant are charged by Bishop Wilkins with great irregularities, with respect both to order, number, power, figure, &c.

As to the order, it appears (says he) inartificial, precarious, and confused, as the vowels and consonants are not reduced into classes, with such order of precedence and subsequence as their natures will bear. Of this imperfection, the Greek alphabet, which is one of the least defective, is far from being free: for instance, the Greeks should have separated the consonants from the vowels; after the vowels they should have placed the diphthongs, and then the consonants; whereas, in fact the order is so perverted that we find the ομικρον, the fifteenth letter in order of the alphabet, and the ωμεγα or long o, the twenty fourth and last, the ε the fifth, and the η the seventh.

With respect to the number, they are both redundant and deficient; redundant by allotting the same sound to several letters, as in the Latin *c* and *k*, *f* and *ph*; or by reckoning double letters among the simple elements of speech, as in the Greek ξ and ψ, the Latin *q* or *cu*, *x* or *ex*, and the *j* consonant; deficient in many respects, particularly with regard to vowels, of which seven or eight kinds are commonly used, though the Latin alphabet takes notice only of five. Add to this, that the difference among them, with regard to long and short, is not sufficiently provided against.

The powers, again, are not more exempt from confusion; the vowels, for instance, are generally acknowledged to have each of them several different sounds; and among the consonants we need only bring, as evidence of their different pronunciation, the letter *c* in the word *circa*, and *g* in the word *negligence*. Hence it happens, that some words are differently written, though pronounced in the same manner, as *cessio* and *sessio*; and others are different in pronunciation, which are the same in writing, as *give*, *dare*, and *give*, *vinculum*.

Finally, the figures are but ill-concerted, there being nothing in the characters of the vowels answerable to the different manner of pronunciation; nor in the consonants analagous to their agreements or disagreements.

Alphabets of different nations vary in the number of their constituent letters. The English alphabet contains twenty-four letters, to which if *j* and *v* consonants are added, the sum will be twenty-six; the French twenty-three; the Hebrew, Chaldee, Syriac, and Samaritan, twenty-two each; the Arabic, twenty eight; the Persian, thirty-one; the Turkish, thirty-three; the Georgian thirty-six; the Coptic thirty-two; the Muscovite, forty-three; the Greek, twenty-four; the Latin, twenty-two; the Sclavonic, twenty-seven; the Dutch, twenty-six; the Spanish, twenty seven; the Italian, twenty; the Ethiopic, as well as Tartarian, two hundred and two; the Indians of Bengal, twenty-one; the Baramos, nineteen; the Chinese, properly speaking, have no alphabet, except we call their whole language their alphabet; their letters are words, or rather hieroglyphics, and amount to about 80,000.

If alphabets had been constructed by

able persons, after a full examination of the subject, they would not have been filled with such contradictions between the manner of writing and reading, as we have shown above, nor with those imperfections that evidently appear in the alphabets of every nation. Mr. Lodowick, however, and Bishop Wilkins, have endeavoured to obviate all these, in their universal alphabets or characters. See CHARACTER.

It is no wonder that the number of letters in most languages should be so small, and that of words so great, since it appears, that, allowing only 24 letters to an alphabet, the different words or combinations that may be made out of them, taking them first one by one, then two by two, &c. &c. would amount to the following number:—1391, 724288, 887252, 999425, 128493, 4022000. See COMBINATION. It must be admitted, nevertheless, that the condition, that every syllable must contain, at least, one vowel, would modify this number in the way of denomination; but on the other hand, the combinations in pollysyllabic words would operate the contrary way.

Many learned authors have composed inquiries into the origin of alphabetic writing, and not a few have referred the invention to the immediate inspiration of God. Nevertheless, it appears to be a very simple and direct improvement of the hieroglyphic art. Sensible objects are depicted in outlines by children, and most rude nations; and, as in the construction of languages, so in this writing by figures, substantives will come to be used adjectively, to denote relations or qualities. As words become more complex and less perfect by the use of abstractions, so likewise must the hieroglypic pictures become combined and imperfect, and at length must have denoted things very different from any object capable of being delineated; and, among other consequences, there is one very striking; namely, that the picture, after degenerating into a sign or character, will be associated by memory with the oral character, or name, or correspondent word. An immediate step after this must be, that characters associated with monosyllabic words will be frequently put together to form pollysyllabic words, in which the picture is left out of the consideration, and the sound alone forms the subject of the record, (as if the characters for man and eye were united to form the word many, or multitudinous.) And lastly, habit must in fact have given a preference, in the composition of these polysyllabic words, to such simple sounds and their characters as were found to be most extensively useful. That is to say, an unintentional process of analysis must have thus given rise to the alphabet.

The sounds of language are modified by articulation, which depends on certain gross, and in general obvious, changes in the figure of the organs; and by accent or mere intensity; and by intonation or music. The first of these, as used in discourse, is much more capable of having its variations marked by characters than the others; and from this circumstance, it is found that the alphabet can deliver with correctness the words of such languages as communicate chiefly by articulation; but in languages where the same articulated monosyllable denotes a great variety of things, according to the accent or intonation, there will be comparatively few instances of depicted sound, and the system of writing will continue to be hieroglyphic, or rather symbolic, in all its improvements. This system is, for the reason here mentioned, in use in China, and does not seem inferior to the alphabet, but in some respects more advangeous.

ALPHABET is also used for a cypher, or table of the usual letters of the alphabet, with the corresponding secret characters, and other blank symbols, intended to render the writing more difficult to be decyphered. See the article DECYPHERING.

ALPHABET, among merchants, a kind of index, with the twenty-four letters in their natural order, in which are set down the names of those who have opened accounts, referring to the folios of the ledger.

ALPHONSINE *tables*, astronomical tables, calculated by order of Alphonsus, King of Castile, in the construction of which that prince is supposed to have contributed his own labour.

ALPINA, in botany, a genus of the Monandria Monogynia class of plants, the corolla whereof is monopetalous, unequal, and as it were double; the exterior one is trifid; the upper segment is hollow, the two side ones flat, and it has a tube; the interior is short, its edge is trifid, and the lower segment of the three hangs out beyond the lateral parts of the exterior corolla, the other two are emarginated, and the base is ventricose; the fruit is a fleshy capsule, of an ovated figure, composed of three valves, and containing three cells; the seeds are numerous, of an ovated figure, with a pro-

minent but truncated apex, and a caudated base. There are seven species.

ALSINE, *chick-weed*, in botany, a genus of the Pentandria Trigynia class and order, and the natural order of Caryophyllei: its characters are, that the calyx is a five-leaved perianthium, leaflets concave, oblong and acuminate: the corolla has five equal petals, longer than the calyx; the stamina consist of capillary filaments, the anthers roundish; the pistillum has a subovate germ, styles filiform, and stigmas obtuse; the pericarpium is an ovate, one-celled, three-valved, capsule, covered with the calyx; the seeds are very many and roundish. There are five species, of which the following is the principal. A. media, common chickweed, with petals bipartite, and leaves ovate cordate. The number of stamens in the flower of the common chick-weed is uncertain, from three to ten. This species in different soils and situations assumes different appearances; but it is distinguished from the cerastiums, which it most resembles, by the number of pistils, and by having the petals shorter than the leaves of the calyx, and from all the plants related to it, and particularly the stellaria nemorum, by having the stalk alternately hairy on one side only. Dr. Withering refers it to the stellaria, with which genus it agrees in various respects, and especially in the capsules opening with six valves. He observes, that it grows almost in all situations, from damp and almost boggy woods, to the driest gravel walks in gardens; but in these various states its appearances are very different, so that those who have only taken notice of it as garden chick-weed would hardly know it in woods, where it sometimes exceeds half a yard in height, and has leaves near two inches long, and more than one inch broad. In its truly wild state, he says, in damp woods, and hedge bottoms, with a northern aspect, it has almost always ten stamens; but in drier soils and more sunny exposures, the stamens are usually five or three. When the flowers first open, the peduncles are upright; as the flowers go off, they hang down; and when the seeds ripen, they again become upright. Dr. Withering observes, that the flowers are upright, and open from nine in the morning till noon; but if it rains, they do not open. After rain they become pendent; but in the course of a few days rise again. In gardens or dunghills, chick-weed sheds abundance of seeds, which are round, compressed, yellow, and rough, with little tubercles; and thus becomes a troublesome weed; but if it be not suffered to seed, it may be destroyed, as it is annual, without much trouble. This species is a remarkable instance of the sleep of plants; for every night the leaves approach in pairs, including with their upper surfaces the tender rudiments of the new shoots; and the uppermost pair but one, at the end of the stalk, is furnished with longer leaf-stalks than the others, so that they can close upon the terminating pair, and protect the end of the branch. The young shoots and leaves, when boiled, can scarcely be distinguished from spring spinach, and are equally wholesome. Swine are very fond of it; cows and horses eat it; sheep are indifferent to it; and goats refuse it. This plant is found wild in most parts of the world. It is annual, and flowers almost through the whole year.

ALSTONIA, in botany, a genus of the Polyandria Monogynia class and order. Essen. char. corol. one-petalled, eight or ten cleft: clefts alternated. There is but one species, a shrub found in South America. It is very smooth, and has the air of the bohea-tea, in the leaves, calyxes, and situations of the flowers. The dried leaves taste like those of Chinese tea.

ALSTROEMERIA, in botany, a genus of the Hexandria Monogynia class and order: cor. six-petalled, somewhat two-lipped; the lower petals tubular at the base: stamina declined. There are six species, all found in South America.

ALT, in music, a term applied to that part of the great scale of sounds, which lies between F above the treble-cleft note and G in altissimo.

ALTAR, a place upon which sacrifices were anciently offered to some deity.

The heathens at first made their altars only of turf; in following times they were made of stone, of marble, of wood, and even of horn, as that of Apollo in Delos. Altars differed in figure as well as in materials. Some were round, others square, and others oval. All of them were turned towards the east, and stood lower than the statues of the gods, and were generally adorned with sculpture, inscriptions, and the leaves and flowers of the particular tree consecrated to the deity. Thus, the altars of Jupiter were decked with oak, those of Apollo with laurel, those of Venus with myrtle, and those of Minerva with olive.

The height of altars also differed according to the different gods to whom they sacrificed. Those of the celestial

gods were raised to a great height above the ground; those appointed for the terrestrial were almost on a level with the surface of the earth; and on the contrary, they dug a hole for the altars of the infernal gods. According to Servius, the first were called *altaria*, the second *aræ*, and the last *crobiculi;* but this distinction is not every where observed, for we find in the best authors, the word *ara*, as a general word, including the altars of celestial, infernal, and terrestrial gods.

Before temples were in use, altars were erected sometimes in groves, sometimes in the high ways, and sometimes on the tops of mountains; and it was a custom to engrave upon them the name, proper ensign, or character of the deity to whom they were consecrated. Thus, St. Paul observed an altar at Athens, with an inscription *To the unknown God.*

In the great temples of ancient Rome, there were ordinarily three altars; the first was placed in the sanctuary, at the foot of the statue of the divinity, upon which incense was burnt, and libations offered: the second was before the gate of the temple, and upon it they sacrificed the victims: and the third was a portable altar, upon which were placed the offerings and the sacred vessels.

Besides these uses of the altars, the ancients swore upon them, and swore by them, in making alliances, confirming treaties of peace, and on other solemn occasions. Altars also served as a place of refuge and sanctuary to all those who fled to them, whatever crime they had committed.

Altar is also used, among Christians, for the communion-table.

ALTERNATE, in heraldry, is said in respect of the situation of the quarters.

Thus the first and fourth quarters, and the second and third, are usually of the same nature, and are called alternate quarters.

ALTERNATION is used for the different ways which any number of quantities may be changed, or combined. See Combination.

ALTHÆA, *marsh-mallow*, in botany, a genus of plants, with a double calyx, the exterior one being divided into nine segments; the fruit consists of numerous capsules, each containing a single seed. It belongs to the Monodelphia Polyandria class and order. There are nine species. The A. officinalis is perennial, and flowers from July to September. It grows plentifully in salt marshes, and on the banks of rivers and ditches, in many parts of England, Holland, France, Italy, Siberia, &c. It has been in great request in every country where medicine has been regularly cultivated. All its parts abound with a glutinous juice, with scarcely any smell or peculiar taste.

ALTIMETRY, denotes the art of measuring altitudes or heights. See Mensuration.

ALTITUDE, in geometry, one of the three dimensions of body; being the same with what is otherwise called height.

Altitude of a figure is the distance of its vertex from its base, or the length of a perpendicular let fall from the vertex to the base.

Thales is supposed to have been the first person who applied the principles of geometry to the mensuration of altitude: by means of the staff he measured the height of the pyramids of Egypt, making the altitude of the staff and pyramid proportional to the length of the shadows.

Altitude, in optics, is the height of an object above a line, drawn parallel to the horizon from the eye of the observer.

Altitude *of the eye*, in perspective, is its perpendicular height above the geometrical plane.

Altitude *of a star, &c.* in astronomy, is an arch of a vertical circle, intercepted between the stars and the horizon.

This altitude is either true or apparent, according as it is reckoned from the rational or sensible horizon, and the difference between these is what is called by astronomers the parallax of altitude. Near the horizon, this altitude is always increased by means of refraction.

Altitude *of the mercury*, in the barometer and thermometer, is marked by degrees, or equal divisions, placed by the side of the tube of those instruments. The altitude of the mercury in the barometer, in and about the metropolis, is usually comprised between 28.4 and 30.6 inches: in the course of the last seven years it has not varied from these limits more than twice. During the same period, the thermometer in the shade has been rarely higher than 82° or 83°, and this seldom more than three or four times in a whole summer, nor often lower than about 8° or 10° below the freezing point. This degree of cold is not common.

ALTO-RELIEVO. See Relievo.

ALUM, in chemistry and the arts, is denominated the sulphate of alumina, though it is not merely a combination of alumina with the sulphuric acid. It possesses the following characters: 1. It has a sweetish astringent taste. 2. It is solu-

ble in warm water, and the solution reddens vegetable colours, which proves the acid to be in excess. 3. When mixed with a solution of carbonate of potash, an effervescence is produced by the uncombined acid, which prevents the first portions of alkali that are added to the solution of sulphate of alumina from occasioning any precipitate. 4. When sulphate of alumina is heated, it swells up, loses its regular form, and becomes a dry spongy mass; but, according to the experiments of Vauquelin, the whole of its acid cannot be thus expelled. 5. The combination of sulphuric acid with alumina is incapable of crystallizing without an addition of potash, which makes a constituent part of all the alum of commerce. 6. It is decomposed by charcoal, which combines with the oxygen of the acid, and leaves the sulphur attached to the alumina.

Dr. Thomson says there are four varieties of alum, all of which are triple salts; two neutral, and two he calls super-salts. These are thus denominated:

1. Sulphate of alumina and potash.
2. Sulphate of alumina and ammonia.
3. Super-sulphate of alumina and potash.
4. Super-sulphate of alumina and ammonia.

The discovery of alum was made in Asia, from whence it continued to be imported till the end of the fifteenth century, when a number of alum works were established in Italy. In the sixteenth century it was manufactured in Germany and Spain; and during Queen Elizabeth's reign an alum manufactory was established in England. The alum of commerce is usually obtained from native mixtures of pyrites and clay, or sulphuric acid and clay. Bergman has published a very complete dissertation on the process usually followed. The earth from which it is procured is usually called aluminous shistus, because it is slaty. Its colour is blackish, because it contains some bitumen. In most cases it is necessary to burn it before it can be employed: this is done by means of a slow smothered fire. Sometimes long exposure to the weather is sufficient to produce an efflorescence of alum on the surface. It is then lixiviated, and the water concentrated by evaporation, and mixed with putrid urine, or muriate of potash; crystals of alum and of sulphate of iron usually form together. The composition of alum has been but lately understood with accuracy. It has been long known, indeed, that one of its ingredients is sulphuric acid; and the experiments of Pott and Margraff proved incontestibly that alumina is another ingredient. But sulphuric acid and alumina are incapable of forming alum. Manufacturers knew that the addition of a quantity of potash or of ammonia, or of some substance containing these alkalies, is almost always necessary, and it was proved, that in every case in which such additions are unnecessary, the earth from which the alum is obtained contains already a quantity of potash. Various conjectures were made about the part which potash acts in this case; but Vauquelin and Chaptal appear to have been the first chemists that ascertained, by decisive experiments, that alum is a triple salt, composed of sulphuric acid, alumina, and potash or ammonia united together. Alum crystallizes in regular octahedrons, consisting of two four-sided pyramids applied base to base. The sides are equilateral triangles. The form of its integrant particles, according to Hauy, is the regular tetrahedron. Its taste is, as we have observed, astringent. It always reddens vegetable blues. Its specific gravity is 1.7109. At the temperature of 60° it is soluble in from 15 to 20 parts of water, and in $\frac{3}{4}$ths of its weight of boiling water. When exposed to the air it effloresces slightly. When exposed to a gentle heat it undergoes the watery fusion A strong heat causes it to swell and foam, and to lose about 44 per cent. of its weight, consisting chiefly of water of crystallization. What remains is called calcined or burnt alum, and is sometimes used as a corrosive. By a violent heat, the greater part of the acid may be driven off. Though the properties of alum are in all cases pretty nearly the same, it has been demonstrated by Vauquelin that three varieties of it occur in commerce. The first is, super-sulphate of alumina and potash; the second, super-sulphate of alumina and ammonia; the third, is a mixture or combination of these two, and contains both potash and ammonia. It is the most common of all; doubtless, because the alum-makers use both urine and the muriate of potash to crystallize their alum. Vauquelin has lately analysed a number of specimens of alum manufactured in different countries. The result was, that they all contain very nearly the same proportion of ingredients. The mean of all his trials was as follows:

Acid	30.52
Alumina	10.50
Potash	10.40
Water	48.58
	100.00

When an unusual quantity of potash is added to alum liquor, the salt loses its usual form, and crystallizes in cubes. This constitutes a fourth variety of alum, usually distinguished by the name of cubic alum. It contains an excess of alkali. When the potash is still further increased, Chaptal has observed, the salt loses the property of crystallizing altogether, and falls down in flakes. This constitutes a fifth variety of alum, consisting of sulphate of potash combined with a small proportion of alumina. If three parts of alum and one of flour or sugar be melted together in an iron ladle, and the mixture dried till it becomes blackish and ceases to swell; if it be then pounded small, put into a glass phial, and placed in a sand-bath till a blue flame issues from the mouth of the phial, and after burning for a minute or two be allowed to cool, a substance is obtained, known by the name of Homberg's pyrophorus, which has the property of catching fire whenever it is exposed to the open air, especially if the air be moist. This substance was accidentally discovered by Homberg about the beginning of the eighteenth century, while he was engaged in his experiments on the human fæces. He had distilled a mixture of human fæces and alum till he could obtain nothing more from it by means of heat; and four or five days after, while he was taking the residuum out of the retort, he was surprised to see it take fire spontaneously. Soon after, Lemery the younger discovered that honey, sugar, flour, or almost any animal or vegetable matter, could be substituted for human fæces; and afterwards Mr. Lejoy de Suvigny shewed that several other salts containing sulphuric acid may be substituted for alum. Scheele proved that alum deprived of potash is incapable of forming pyrophorus, and that sulphate of potash may be substituted for alum. And Mr. Proust has shewn that a number of neutral salts, composed of vegetable acids and earths, when distilled by a strong fire in a retort, leave a residuum which takes fire spontaneously on exposure to the air. These facts have thrown a great deal of light on the nature of Homberg's pyrophorus, and enabled us in some measure to account for its spontaneous inflammation. It has been ascertained, that part of the sulphuric acid is decomposed during the formation of the pyrophorus, and of course a part of the alkaline base becomes uncombined with acid; and the charcoal, which gives it its black colour, is evidently divided into very minute particles. It has been ascertained, that during the combustion of the pyrophorus a quantity of oxygen is absorbed. The inflammation is probably occasioned by the charcoal; the sulphuret of potash also acts an essential part. Perhaps it produces a sudden increase of temperature, by the absorption and solidification of water from the atmosphere.

A new process for making alum is used at some works, for which we are indebted to Mr Sadler, which is as follows: The boilers are filled with prepared liquor of 10 pennyweights, to which sulphate of potash is added, and boiled together, until it weighs 16 pennyweights, by which time the whole of the superfluous alumina and the oxyde of iron is precipitated. The fluid is then run into a settler, where it remains until clear, after which it is pumped into a second boiler, and evaporated up to 26 pennyweights, let into the coolers, and left to crystallize. By this process, it is said, he gains the whole of the alum at one evaporation, and from the mother liquor remaining there is a product, the sulphate of iron.

ALUMINA, in chemistry, one of the five proper earths. It was discovered by the alchemists that alum was composed of sulphuric acid and an earth, the nature of which was long unknown; but Geoffroy, and afterwards Margraff, found that the earth of alum is an essential ingredient in clays, and gives them their properties, hence it was called *argil;* but Morveau gave it the name of *alumina,* because it it obtained in a state of the greatest purity from alum by the following process. Dissolve alum in water, and add to the solution ammonia as long as any precipitate is formed. Decant off the fluid part, and wash the precipitate in a large quantity of water, and then allow it to dry. The substance thus obtained is alumina: not however in a state of absolute purity, for it still retains a portion of the sulphuric acid with which it was combined in the alum. But it may be rendered tolerably pure, by dissolving the newly precipitated earth in muriatic acid, evaporating the solution till a drop of it in cooling deposits small crystals, setting it by to crystallize, separating the crystals, concentrating the liquid a second time, and separating the crystals which are again deposited. By this process, most of the alum which the earth retained will be separated in crystals. If the liquid be now mixed with ammonia as long as any precipitate appears, this precipitate, washed and dried, will be alumina nearly pure.

Alumina has little taste: when pure, it has no smell; but if it contains oxyde of iron, which it often does, it emits a peculiar smell when breathed upon, known by the name of earthy smell. This smell is very preceptible in common clays. The specific gravity of alumina is 2.00. When heat is applied to alumina, it gradually loses weight, in consequence of the evaporation of a quantity of water, with which, in its usual state, it is combined; at the same time its bulk is considerably diminished. The spongy alumina parts with its moisture very readily; but the gelatinous retains it very strongly. Spongy alumina, when exposed to a red heat, loses 0.58 parts of its weight; gelatinous, only 0,43: spongy alumina loses no more than 0.58 when exposed to a heat of 130° Wedgewood; gelatinous in the same temperature loses but 0.4825. Yet Saussure has shown that both species, after being dried in the temperature of 60°, contain equal proportions of water. Alumina undergoes a diminution of bulk proportional to the heat to which it is exposed. This contraction seems owing, in low temperatures, to the loss of moisture; but in high temperatures it must be owing to a more intimate combination of the earthy particles with each other; for it loses on perceptible weight in any temperature, however high, after being exposed to a heat of 130° Wedgewood.

Mr. Wedgewood took advantage of this property of alumina, and by means of it constructed an instrument for measuring high degrees of heat. It consists of pieces of clay of a determinate size, and an apparatus for measuring their bulk with accuracy; one of these pieces is put into the fire, and the temperature is estimated by the contraction of the piece. The contraction of the clay pieces is measured by means of two brass rules, fixed upon a plate, the distance between which at one extremity is 0.5 inch, and the other extremity 0.3 inch; and the rules are exactly 24.0 inches in length, and divided into 240 equal parts, called degrees. These degrees commence at the widest end of the scale. The first of them indicates a red heat, or 947° Fahrenheit. The clay-pieces are small cylinders, baked in a red heat, and made so as to fit 1° of the scale. They are not composed of pure alumina, but of a fine white clay. Alumina is scarcely soluble in water; but may be diffused through that liquid with great facility. Its affinity for water, however, is very considerable. In its usual state it is combined with more than its own weight of water, and we have seen with what obstinacy it retains it. Even this combination of alumina and water is capable, in its usual state of dryness, of absorbing 2½ times its weight of water, without suffering any to drop out. It retains this water more obstinately than any of the earths hitherto described. In a freezing cold it contracts more, and parts with more of its water, than any other earth; a circumstance which is of some importance in agriculture. Alumina has no effect upon vegetable blues. It cannot be christallized artificially; but it is found native in beautiful transparent crystals, exceedingly hard, and having a specific gravity of 4. It is distinguised in this state by the name of *sapphyr*. It does not combine with metals; but it has a strong affinity for metallic oxydes, especially for those oxydes which contain a maximum of oxygen. Some of these compounds are found native. Thus, the combination of alumina and red oxyde of iron often occurs in the form of a yellow powder, which is employed as a paint, and distinguished by the name of ochre. There is a strong affinity between the fixed alkalies and alumina. When heated together, they combine, and form a loose mass, without any transparency. Liquid fixed alkali dissolves alumina by the assistance of heat, and retains it in solution. The alumina is precipitated again, unaltered, by dropping an acid into the solution. This is a method employed by chemists to procure alumina in a state of complete purity; for alumina, unless it be dissolved in alkali, almost always retains a little oxyde of iron and some acid, which disguise its properties. Liquid ammonia is also capable of dissolving a very minute proportion of newly precipitated alumina. Barytes and strontian also combine with alumina, both when heated with it in a crucible, and when boiled with it in water. The result, in the first case, is a greenish or bluish-coloured mass, cohering but imperfectly: in the second, two compounds are formed; the first, containing an excess of alumina, remains in the state of an insoluble powder; the other, containing an excess of barytes or strontian, is held in solution by the water. Alumina has a strong affinity for lime, and readily enters with it into fusion. None of the earths is of more importance to mankind than alumina; it forms the basis of china and stone-ware of all kinds, and of the crucibles and pots employed in all those manufactures which require a strong heat. It is absolutely necessary to the dyer and

calico printer, and is employed too, with the greatest advantage, by the fuller and cleaner of cloth.

ALURNUS, in natural history, a genus of insects of the order Coleoptera. Essen. character: antennæ filiform, short; feelers four to six, very short: jaw horney, arched. There are three species— A. grossus, an inhabitant of South America and India: A. femoratus, found in India: and A. dentipes, found at the Cape of Good Hope.

ALYSSO, or ALYSSUM, *mad wort*, in botany, a genus of the Tetradynamia Essculosa class of plants; the flower is of the cruciform kind, and consists of four leaves; the fruit is a small roundish capsule, divided into two cells, in which are contained a number of small roundish seeds.

The alyssum is arranged in three divisions, viz. into A. in which the stem is somewhat shrubby: B. stems herbaceous: C. silules inflated, or calyx oblong, closed. There are 33 species; but according Martyn only 17. All the species may be propagated by seed, and most of them by slips and cuttings. In rich ground they seldom live through the winter in England; but in dry, poor, rubbishy soil, or on old walls, they will abide the cold, and last much longer.

AMALGAM, in the arts. The metals in general unite very readily with one another, and form compounds; thus pewter is a compound of lead and tin, brass is a compound of copper and zinc, &c. These are all called alloys, except when one of the combining metals is mercury; in that case the compound is called an *amalgam*: thus mercury and gold form a compound called the amalgam of gold.

The amalgam of gold is formed very readily, because there is a very strong affinity between the two metals. If a bit of gold be dipped into mercury, its surface, by combining with mercury, becomes as white as silver. The easiest way of forming this amalgam is, to throw small pieces of red hot gold into mercury heated till it begins to smoke. The proportions of the ingredients are not determinable, because they combine in any proportion. This amalgam is of a silvery whiteness. By squeezing it through leather, the excess of mercury may be separated, and a soft white amalgam obtained, which gradually becomes solid, and consists of about one part of mercury to two of gold. It melts at a moderate temperature; and in a heat below redness the mercury evaporates, and leaves the gold in a state of purity. It is much used in gilding. The amalgam is spread upon the metal which is to be gilt; and then, by the application of a gentle and equal heat, the mercury is driven off, and the gold left adhering to the metallic surface: this surface is then rubbed with a brass wire brush under water, and afterwards burnished. The amalgam of silver is made in the same manner as that of gold, and with equal ease. It forms dentrical crystals, which contain eight parts of mercury and one of silver. It is of a white colour, and is always of a soft consistence. Its specific gravity is greater than the mean of the two metals. Gillert has even remarked, that when thrown into pure mercury, it sinks to the bottom of that liquid. When heated sufficiently, the mercury is volatilized, and the silver remains behind pure. This amalgam is sometimes employed, like that of gold, to cover the surfaces of the inferior metals with a thin coat of silver. The amalgam of tin and mercury is much used in electricity. See GILDING.

AMARANTHUS, in botany, a genus of the Monoecia Pentandria class and order, of the Triandria Tryginia of Gmelin's Linnæus; its characters are, that those species which have male flowers on the same plants with the females have a calyx, which is a five or three-leaved perianthium, upright, coloured, and permanent; the leaflets lanceolate and acute; no corolla; the stamina have five or three capillary filaments, from upright, patulous, of the length of the calyx, the anthers oblong and versatile: of those which have female flowers in the same receme with the males, the calyx is a perianthium the same with the former; no corolla; the pistillum has an ovate germ, styles three, short and subulate; stigmas simple and permanent; the pericarpium is an ovate capsule, somewhat compressed, as is also the calyx on which it is placed, coloured, and of the same size, three-beaked, one-celled, cut open transversely; the seed is single, globular, compressed, and large. There are 22 species, of which we notice A. melancolicus, two-coloured A. with glomerules, axillary, peduncled, roundish, and leaves ovate-lanceolate, and coloured. This species varies in the colour of the leaves; being in the open air of a dingy purple on their upper surface, and the younger ones green; in a stove the whole plant is purple-coloured; but it is easily distinguished in all states by its colour, leaves, and the lateness of its flowering, after all the

others are past: it is joined by La Marck with a tri-colour; a native of Guiana and the East-Indies, and cultivated in 1731 by Miller. The obscure purple and bright crimson of the leaves are so blended as to set off each other, and, in the vigorous state of the plants, make a fine appearance. A. tri-color, three-coloured A. with glomerules sessile, roundish; stem clasping, and leaves lanceolate-ovate, coloured. This has been long cultivated, being in the garden of Gerard in 1596, for the beauty of its variegated leaves, in which the colours are elegantly mixed; these, when the plants are vigorous, are large and closely set from the bottom to the top of the stalks, and the branches form a kind of pyramid, and therefore there is not a more handsome plant when in full lustre: a native of Guiana, Persia, Ceylon, China, Japan, the Society Isles, &c. A. lividus, livid A. These are the most worthy of a place in the pleasure-garden; but they are tender, and require attention. They are usually disposed in pots, with cocks-combs and other showy plants, for adorning court-yards, and the environs of the house. The seeds of these should be sown in a moderate hot-bed, about the end of March; and when the plants come up, they should have much air in mild weather. When they are fit for transplanting, they should be removed to another moderate hot-bed, and placed at six inches distance, watering and shading them till they have taken new root; afterwards they should have free air, and frequent but gentle waterings. In the beginning of June they should be taken up, with large balls of earth to their roots, and planted either in pots or the borders of the pleasure-garden, shaded till they have taken root, and afterwards frequently watered in dry weather. The tree amaranth must be planted in a rich light soil, and if it be allowed room, and well watered in dry weather, it will grow to a large size, and make a fine appearance. The other sorts are sufficiently hardy to bear the open air, and may be sown on a bed of light earth, in the spring, and when the plants are fit to remove, transplanted into any part of the garden, where they will thrive, and produce plenty of seeds.

AMARILLIS, in botany, a genus of the Hexandria Monogynia class and order, of the natural order of Liliæ or Liliaceæ; its characters are, that the calyx is a spathe, oblong, obtuse, compressed, emarginate, gaping on the flat side, and withering; the corolla has six petals, lanceolate, the nectary has six very short scales without the base of the filaments; the stamina have six awl-shaped filaments, with oblong, incumbent, rising anthers; the pistillum has a roundish, furrowed, inferior germ, the style filiform, almost of the length and in the situation of the stamens, the stigma trifid and slender; the pericarpium is a subovate, three-celled, three-valved capsule; and the seeds are several. The inflection of the petals, stamens, and pistil, is very various in the different species of this genus; and the corolla in most of the species is rather hexapetaloid than six-petalled. Gmelin reckons 27 species. A lutea, yellow, A. or autumnal narcissus, with an undivided obtuse spathe, sessile; flower bell shaped; corolla erect, shortly tubular at the base, and erect stamens, alternately shorter; the flowers seldom rise above three or four inches high; the green leaves come up at the same time, and when the flowers are past, the leaves increase through the winter. This species recedes a little from the genus. It is a native of the south of France, Spain, Italy, and Thrace: was cultivated by Gerard, in 1596, and flowers in September. A. formosissima, jacobea lily, so called, because some imagined that they discovered in it a likeness to the badge of the order of the knights of the order of St. James, in Spain, the lilio-narcissus and narcissus of others, with a spathe undivided, flower pedicelled, corolla two-lipped, nodding, deeply six-parted stamens, and pistil bent down. The flowers are produced from the sides of the bulbs, are large, of a deep red, and make a beautiful appearance: it is a native of America, first known in Europe in 1593, some roots of it having been found on board a ship which had returned from South America, by Simon de Jovar, a physician at Seville, who sent a description of the flowers to Clusius, who published a drawing of it in 1601, called, by Parkinson, who figured it in 1629, the Indian daffodil, with a red flower: cultivated in the Oxford Garden in 1658. A. reginæ, Mexican lily, with spathe, having about two flowers, pedicels divaricating, corollas bell-shaped, shortly tubular, nodding, throat of the tube hirsute, and leaves lanceolate, patulous; the bulb is green, corolla scarlet, and at the bottom whitish green, the style red, the flowers large, of a bright copper colour, inclined to red: it flowered in Fairchild's garden, at Hoxton, in 1728; and Dr. Douglas wrote a folio pamphlet upon it, giving it the title of lilium reginæ, because it was in full beauty on the first of March,

the queen's birth-day: the roots were brought from Mexico, and therefore Mr. Fairchild called it Mexican lily, the name which it has retained. It flowers in the spring in a very warm stove; is in beauty in February; and in a moderate temperature of air will flower in March or April. A. sarniensis, lilium sarniense of Douglas, who published a description of it in 1725; narcissus of others; Guernsey lily, so called by Mr. Ray in 1665; with petals linear, flat, stamens and pistil straightish, longer than the corolla, stigmas, parted and revolute. The bulb is an oblong spheroid; the leaves are dark willow green; the number of flowers is commonly from eight to twelve, and circumference of each about seven inches; the corolla, in its prime, has the colour of a fine gold tissue, wrought on a rose-coloured ground, and when it begins to fade, it is a pink: in full sunshine, it seems to be studded with diamonds, but by candle-light the specks or spangles appear more like fine gold dust; when the petals begin to wither, they assume a deep crimson colour. The flowers begin to come out at the end of August, and the head is usually three weeks in gradually expanding. This beautiful plant is a native of Japan, and has been long naturalized in Guernsey. It is said to have been brought from Japan to Paris, and cultivated in Morin's garden before 1634. It was cultivated at Wimbledon, in England, by General Lambert, in 1659, and in 1664 became more common: it does not seem to have been in Holland before 1695. The plants are reputed to owe their origin in Guernsey to the shipwreck of a vessel returning from Japan, probably before the middle of the seventeenth century. The bulbs, it is said, being cast on shore, took root in that sandy soil, and produced beautiful flowers, which engaged the attention of Mr. Hatton, the governor's son, who sent roots to several of his friends. A variety of this, found at the Cape of Good Hope, is described by Jacquin with a many-flowered spathe, corollas very patent and reflex at the apex, stamens and pistil somewhat straight, longer than the corolla, and leaves ensiform-linear. Most of these species have very beautiful flowers, and merit the attention of the botanist and florist. The first, or yellow autumnal A. is very hardy, and increases by offsets. The season for transplanting these roots is from May to the end of July, when the leaves are decayed. They will grow in any soil or situation; but they will thrive best in a fresh, light, dry soil, and open situation, and will keep flowering from the beginning of September to the middle of November, provided that they escape severe frosts; and a succession of flowers will spring from the same root. The Guernsey lily has been cultivated for many years in the gardens of Guernsey and Jersey, whence the roots are sent to most parts of Europe. The bulbs are commonly brought over in June and July, and they should then be planted in pots filled with fresh, light, sandy earth, mixed with a small quantity of very rotten dung, placed in a warm situation, and occasionally refreshed with water. About the middle of September the stronger roots will shew their red-coloured flower-stem; and then the pots should be removed into a situation where they may have the full benefit of the sun, and be sheltered from strong winds; but not placed under glasses, or too near a wall, which would draw them up, and render them less beautiful. When the flowers begin to open, the pots should be put under shelter, so as to be secure from too much wet, but not kept too close or too warm. The flowers will continue in beauty for a month; and, though without scent, their rich colour entitles them to the first rank in the flowery tribe.

AMASONIA, in botany, a genius of the Didynamia Angiospermia class and order: calyx five cleft: corolla tubular, with a small five-cleft border: berry four-seeded. There are two species.

AMATEUR, in the arts, denotes a person understanding, loving, or practising the fine arts, without any regard to pecuniary advantage.

AMBASSADOR, a person appointed by one sovereign power to another, to superintend his affairs at some foreign court, and supposed to represent the power from which he is sent. The person of an ambassador is inviolable.

AMBER, in mineralogy, a resinous substance, called by the ancients electrum, found in different countries; but most abundantly in Prussia, either on the seashore, or under ground, at the depth of 100 feet, reposing on wood coal. It is obtained in lumps of different sizes. There are the white and the yellow amber. 1. The white amber is in colour straw-yellow, inclining to yellowish white; but 2. The yellow amber is a wax-yellow passing to a honey-yellow, yellowish brown, and hyacinth-red. It is found in blunt pieces, with a rough surface. It is rather brittle, and its specific gravity is from 1.07 to 1.08. Amber burns with a yellow-co-

loured flame, and, if the heat be strong enough, melts, and emits a peculiar agreeable odour, and leaves little ashes. When rubbed, it acquires a strong negative electrical virtue. From this property is derived the word electricity. It is composed of carbon, hydrogen, and oxygen. Amber is often found in the alluvial deposit (usually called Marle) of New-Jersey. According to Sir J. Hill, it is said that amber has been found in digging into the alluvial land in the vicinity of London. It is found sometimes on the seashores of several parts of England. Being susceptible of a fine polish, it is cut into necklaces, bracelets, snuff-boxes, and other articles of dress. Before the discovery of the diamond and other precious stones of India, it was considered to be the most precious of jewels, and was employed in all kinds of ornamental dress: altars were likewise ornamented with it. The greatest quantity at present consumed in commerce is purchased by Armenian and Grecian merchants, for the use, it is conjectured, of pilgrims, previously to their journey to Mecca, and that on their arrival there it is burnt in honour of the prophet Mahomet. The acid and oil obtained from it are used as medicines.

If often contains insects of various species, in a state of complete preservation, also leaves, and other parts of vegetables. Various conjectures have been made respecting its origin and formation. By some it is, as we have already seen, considered as a vegetable gum or resin; others regard it as a mineral oil, thickened by the absorption of oxygen; and Mr. Parkinson is of opinion, that it is inspissated mineral oil. There was lately found in Prussia a mass of amber which weighed upwards of 13 pounds, the contents of which amounted to 318¾ cubic inches. Five thousand dollars are said to have been offered for it; and the Armenian merchants assert, that in Constantinople it would sell for six times that price at least. Pitch-coal is sometimes found with amber, and is called black, and is sold to the ignorant at a great price. Specimens inclosing insects, &c. are highly valued, and the amber-dealers are said to be possessed of means of softening it, in order to introduce insects and other foreign bodies into it. Two parts of the empyreumatic oil obtained by distilling mineral pitch boiled several times, with three parts of turpentine, form a compound, which bears a great resemblance to amber, and which is often cut into necklaces and other ornaments, and sold as true amber.

AMBERGRIS, in chemistry, is a substance found floating on the sea, near the coasts of India, Africa, and Brazil, usually in small pieces, but sometimes in masses of 50 or 100 pounds in weight. Various opinions have been entertained concerning its origin. Some affirmed that it was the concrete juice of a tree; others thought it a bitumen; but it is now established, that it is a concretion, formed in the stomach or intestines of the physeter macrocephalus, or spermaceti whale. Ambergris, when pure, is a light soft substance which swims on water. Its specific gravity varies from 0.78 to 0.844. Its colour is ash-grey, with brownish yellow and white streaks. It has an agreeable smell, which improves by keeping. Its taste is insipid. When heated to 122°, it melts without frothing; if the heat be increased to 212°, it is volatilized completely in a white smoke, leaving only a trace of charcoal. When distilled, we obtain a whitish acid liquid and a light volatile oil; a bulky charcoal remains behind. It is insoluble in water. Acids have little action on it. Weak sulphuric acid occasions no change; but, when concentrated, it developes a little charcoal. Nitric acid dissolves it, giving out at the same time nitrous gas, carbonic acid, and azotic gas. A brownish liquid is formed, which leaves, when evaporated to dryness, a brittle brown substance, possessing the properties of a resin. The alkalies dissolve it by the assistance of heat, and form a soap soluble in water. Both the fixed and volatile oils dissolve ambergris. It is soluble also in ether and alcohol. It possesses the properties of the salty matter into which the muscles are converted by nitric acid, and which makes its appearance when dead bodies are allowed to putrefy in great numbers together. This substance has been distinguished by the name of adipocire, from its resemblance both to fat and wax. The quantity of it in ambergris amounts to 52.8 parts. According to the analysis of ambergris made by Bouillon La Grange, it is composed of

52.7	adipocire
30.8	resin
11.1	benzoic acid
5.4	charcoal
1.000	

AMBIDEXTER, a peson who can use both hands with the same facility, and for the same purposes, that the generality of people do their right hands.

Were it not for education, some think

that all mankind would be ambidexters; and, in fact, we frequently find nurses obliged to be at a good deal of pains before they can bring children to forego the use of their left hands. It is to be regretted, that any of the gifts of nature should be thus rendered in a great measure useless, as there are many occasions in life which require the equal use of both hands: such as the operations of bleeding in the left arm, left ancle, &c.

AMBROSIA, in botany, the name of a distinct genus of plants, with flosculous flowers, composed of several small infundibuliform floscules, divided into five segments; these, however, are barren; the fruit, which in some measure resembles a club, growing on other parts of the plant.

This genus belongs to the Monoecia Pentandria class and order. There are five species.

AMBROSINIA, in botany, a genus of the Monoecia Monadelphia class and order; of which there is a species found in the island of Sicily: spathe one-leafed, separated by a membranaceous partition, containing the stamina in the hinder cell and upper part of the partition, pistils in the outer cell, and lower part of the partition: the root is tuberous; leaves radical, ovate, and shining.

AMBUSCADE, or AMBUSH, in the military art, properly denotes a place where soldiers may lie concealed, till they find an opportunity to surprise the enemy.

AMELLUS, in botany, a genus of the Syngenesia Superflua: receptacle chaffy; down simple: calyx imbricate: florets of the ray divided. There are three species.

AMELIORATING *crops*, in husbandry, are such as are supposed to improve the lands on which they are cultivated. Most of those plants which have a large stem and shady leaf are thought to renders the soils on which they grow more fertile, by producing a confined or stagnant state of the air. The improvement of lands, by what are called ameliorating crops, probably depends upon the culture which the ground receives while they are growing, and the returns which they make to it in the way of manure, after they are consumed by animals.

AMEN, in the scripture language, a solemn formula, or conclusion to all prayer, signifying, *so be it*.

The term *amen* is Hebrew, being derived from the verb, *aman, i. e.* to be true, faithful, &c. so that, strictly speaking, it signifies truth; and, used adverbially, as is frequently done in the gospels, truly or verily. Sometimes it is repeated twice together, and then it stands for the superlative, as *amen, amen, dico vobis*.

The word, in music, forms the usual conclusion of anthems, hymns, and other sacred compositions; and has so long been one of the principal themes of choral harmony, as to have given birth to a distinct appellation for music adapted to its expression: as when, using the word adjectively, we say, such an oratorio or anthem concludes with an *Amen* chorus.

AMEND, or AMENDE, in the French customs, a pecuniary punishment imposed by a judge for any crime, false prosecution, or groundless appeal.

AMENDE *honorable*, an infamous kind of punishment inflicted in France upon traitors, parricides, or sacrilegious persons, in the following manner: the offender being delivered into the hands of the hangman, his shirt is stripped off, and a rope put about his neck, and a taper in his hand; then he is led into court, where he must beg pardon of God, the King, the Court, and his Country. Sometimes the punishment ends here, but sometimes it is only a prelude to death, or banishment to the gallies.

Amende honorable is a term also used for making recantation in open court, or in presence of the person injured.

AMENDMENT, in law, the correction of an error committed in a process, which may be amended after judgment, unless the error lies in giving judgment, for in that case it is not amendable, but the party must bring a writ of error.

A bill may be amended on the file at any time before the plea is pleaded; but not afterwards, without motion and leave of the court.

AMERCEMENT, or AMERCIAMENT, in law, a pecuniary punishment imposed upon offenders at the mercy of the court. Amercements differ from fines, the latter being certain punishments growing expressly from some statute, whereas the former are imposed arbitrarily, in proportion to the fault.

Besides, fines are assessed by the court, but amercements by the country.

A court of record only can fine, all others can only amerce.

Sheriffs are amerceable for the faults of their officers, and clerks of the peace may be amerced in the King's-bench for gross faults in indictments removed to that court.

A town is subject to amercement for the escape of a murderer in the day-time, and if the town is walled, it is subject to

amercement, whether the escape happens by day or night.

The statute of Magna Charta ordains, that a freeman is not to be amerced for a small fault, but in proportion to the offence, by his peers and equals.

AMERIMNUM, or AMERIMNON, in botany, a genus of the Diadelphia Decandria class and order; of the natural order of Papilionaceæ or Leguminosæ; the characters of which are, that the calyx is a one-leafed perianthium; tube bell shaped, five toothed, the teeth sharp; the corolla papilionaceous, standard with an oblong claw, roundish, heart-shaped, expanding and convex, wings lanceolate, shorter than the standard, and keel short; the stamina have ten filaments conjoined, anthers roundish; the pistillum has a gum pedicelled, oblong, compressed, leafy, varicose, with lateral veins, within woody, not gaping; cells disposed longitudinally within: the seeds solitary, kidney-shaped, thicker at the base, appendicted at the top. There are two species, viz. 1. A. Brownei: this shrub rises commonly to the height of ten feet, and supports itself on other shrubs. It is a native of Carthagena, Jamaica, and Domingo. 2. A. ebenus, Jamaica ebony, which is common in Jamaica and several other parts of the West Indies, where the wood is cut, and sent into England under the name of ebony, though the true ebony is a native of the eastern country, and of a different genus. This wood is of a fine greenish brown colour, admits of polishing well, so that it is much valued by the instrument makers, and it is of a very hard durable nature. Dr. Browne says, that the trunk seldom exceeds three or four inches in diameter; that the slender branches, being very tough and flexible, are used for riding switches, and kept at all the wharfs about Kingston, to scourge the refractory slaves.

AMETHYST, in mineralogy, is one of the Quartz family; it occurs massive and in rolled pieces, but most frequently crystallized. The crystals are six-sided pyramids: colour violet blue, passing on the one hand to plum blue, brown, brownish black; on the other to pearl and ash grey, greyish white, greenish white, olive green, and in some rare cases pistachio green. In massive varieties several colours appear together in stripes: in this state they are composed of thick prismatic distinct concretions, often shooting into crystals at their extremities. Specific gravity 2.75. It is found in veins, and in the hollow cavities of agate. It is composed of

Silica	97.50
Alumina	0.25
Oxide of iron	0.50
and a Trace of manganese	
	98.25

It is found abundantly in different parts of Saxony: also in the Hartz, in the Uralian mountains, and in the East Indies. The most beautiful varieties are found at Catharinaburg in Russia. It is cut into rings, seals, and boxes, but it is not very highly valued. The green is the chrysolite of some authors: the oriental amethyst is the sapphire: it is sometimes covered with capillary crystals of iron mica, and when viewed in certain positions appears red; this variety is named the hair amethyst.

AMETHYST, in heraldry, a term for the purple colour in the coat of a nobleman, in use with those who blazon by precious stones instead of metals and colours. This in a gentleman's escutcheon is called purpure, and in those of sovereign princes mercury.

AMETHYSTEA, *amethyst*, so called from the amethystine colours of the flowers, in botany, a genus of the Diandria Monogynia class; the characters are, that the calyx is a perianthium one-leafed, tube bell-shaped, angular, semiquinquefid, subequal, acuminate, and permanent; the corolla is one-petalled, ringent, little longer than the calyx; border five-parted and subequal; upper lip erect, roundish, concave, two-parted, gaping; lower three-parted; the sides rounded, erect, shorter; the middle quite entire, concave, the length of the upper lip; the stamina have filaments, filiform, approximating, under the upper lip, and longer than it; anthers simple and roundish; the pistillum is a quadrifid germ, style size of the stamens, stigmas two, and acute; no pericarpium, but the calyx becomes more bell-shaped and spreading; the seeds are four, shorter than the calyx; obtuse, and angular within. There is one species, viz. A. cœrulia, mountain upright A. which is a native of the mountains in Siberia, from whence the seeds were sent to the Imperial garden at Petersburgh, and in 1759 to Chelsea garden, where the plants annually produce seeds. It is annual, and hath an upright stalk, which rises about a foot high, and towards the top puts out two or three small lateral branches; these are garnished with small trifid leaves, sawed on their edges, and of a very dark green colour; at the extremity of the

branches the flowers are produced in small umbels; these are of a fine blue colour, as are also the upper part of the branches, and the leaves immediately under the umbel; so that though the flowers are small, yet, from their colour, with that of the upper part of the stalks, the plants make a pretty appearance during their continuance in flower.

AMIA, in natural history, a genus of fishes of the order Abdominales. Generic character: head bony, naked, rough, with visible sutures. Teeth, both in jaws and palate, close-set, sharp, numerous. Cirri or beards two, near the nostrils. Gill-membrane twelve-rayed: body scaly. There is a single species, Calva, a small fresh water fish, inhabiting some parts of Carolina, of which the tail is rounded, and with a black spot; it is seldom eaten.

AMIABLE, or *amicable numbers*, such as are mutually equal to the sum of one another's aliquot parts, as the numbers 284 and 220.

Van Schouten was the first who gave this name to such numbers, of which there are but very few at least to be set down and manageable by us. For 284 and 220 are the two least. The aliquot parts of 220 are 1, 2, 4, 5, 10, 11, 20, 22, 44, 55, 110, and the sum of these is equal 284. The aliquot parts of 284 are 1, 2, 4, 71, 142, and the sum of these is 220. The second pair of applicable numbers are 17296 and 18416. The third pair are 9363584 and 9437056.

AMIANTHUS. See ASBESTOS.

AMICUS *curiæ*, in law, if a judge be doubtful or mistaken, in a matter of law, a bystander may inform the court as *amicus curiæ*.

AMMANNIA, named by Houstoun in honour of J. Amman, in botany, a genus of the Tetrandria Monogynia class and order. Its characters are, that the calyx is a perianthium, bell-shaped, oblong, erect, with eight streaks and folds, quadrangular, eight-toothed, teeth alternate, bent in, and permanent; corolla none, or four-petalled, petals vertically ovate, spreading, inserted into the calyx; the stamina have filaments, (four or eight) bristly, the length of the calyx into which they are inserted, anthers twin; the pistillum is a germ subovate, large and superior, style simple, very short, and stigma headed; the pericarpium is a roundish, four-celled capsule (bury) covered with the calyx; the seeds are numerous and small.

AMMI, *bishop's weed*, in botany, a distinct genus of umbelliferous plants, belonging to the Pentandria Digynia class of Linnæus; the flower of which is rosaceous, and composed of heart-like petals; and its fruit is a small roundish and striated capsule, containing two striated seeds, convex on one side, and plane on the other. There are four species.

AMMODYTES, in natural history, the *launce*, a genus of fishes, of the order Apodes: head compressed, narrower than the body: upper lip doubled: lower jaw narrow, pointed: teeth small and sharp. Gill-membrane seven-rayed: body long, roundish, with very small scales: tail distinct. A. tobianus, or sand launce, so named from its shape. It inhabits the northern seas; and is from 9 to 12 inches long. It buries itself on the recess of the tides a foot deep in the sand, and in fine weather rolls itself up and lifts its nose just above the sand; it is the prey of other rapacious fish; the flesh is tolerably good, but it is used in most cases as baits. The launce lives on worms, water-insects, and small fishes, and even occasionally on those of its own species. The mackarel is very partial to this fish as its own food. The launce spawns in May, depositing its eggs in the mud, near the edges of the coast.

AMMONIA, in chemistry. Volatile alkali, in its purest form, subsists in a state of gas, and was thought, till the late experiments of Mr. Davy, to be composed of azote and hydrogen. It may be obtained in the following manner: put into a retort a mixture of three parts of quick-lime and one part of sal ammoniac in powder. Plunge the beak of the retort below the mouth of a glass jar filled with mercury, and standing inverted in a basin of mercury. Apply the heat of a lamp to the retort: a gas comes over, which displaces the mercury and fills the jar. This gas is ammonia. It was known by the name of volatile alkali; it was also called hartshorn, because it was often obtained by distilling the horn of the hart; spirit of urine, because it may be obtained by the same process from urine; and spirit of sal ammoniac, because it may be obtained from that salt. Dr. Black first pointed out the difference between ammonia and carbonate of ammonia, or ammonia combined with carbonic acid; and Dr. Priestley discovered the method of obtaining it, in a state of purity, by the process already described. Ammonia, in the state of gas, is transparent and colourless like air; its taste is acrid and caustic like that of the fixed alkalies, but not nearly so strong, nor

does it like them corrode those animal bodies to which it is applied; its smell is remarkably pungent, though not unpleasant when sufficiently diluted. Its use as a stimulant to prevent fainting is well known. Animals cannot breathe it without death. When a lighted candle is let down into this gas, it goes out three or four times successively; but at each time the flame is considerably enlarged by the addition of another flame of a pale yellow colour, and at last this flame descends from the top of the vessel to the bottom. Its specific gravity, according to the experiments of Kirwan, is 0.60, that of air being 1.00; while Mr. Davy, whose gas was probably purer, found it 0.55. At the temperature of 60°, a hundred cubic inches of this gas weigh, according to Kirwan, 18.16 grains, according to Davy, 17.068. Hence it is to common air nearly as 3 to 5. When exposed to a cold of —45° it is condensed into a liquid, which again assumes the gaseous form, when the temperature is raised. When passed through a red hot tube of porcelain or glass, it is totally decomposed, and converted into hydrogen and azotic gas. It combines very rapidly with water. When a bit of ice is brought into contact with this gas, it melts, and absorbs the ammonia, while at the same time its temperature is diminished. Cold water absorbs this gas almost instantaneously, and at the same time heat is evolved, and the specific gravity of the water is diminished. Water is capable of absorbing and condensing more than a third of its weight of ammoniacal gas. It is in this state that ammonia is usually employed by chemists. The term ammonia almost always means this liquid solution of ammonia in water. When heated to the temperature of about 130°, the ammonia separates under the form of gas. When exposed to the temperature of — 46°, it crystallizes; and when suddenly cooled down to — 68°, it assumes the appearance of a thick jelly, and has scarcely any smell. It follows, from the experiments of Mr. Davy, that a saturased solution of ammonia is composed of

74.63	water.
25.37	ammonia.
100.00	

Charcoal absorbs ammoniacal gas, but does not alter its properties while cold. But when the gas is made to pass through red hot charcoal, part of the charcoal combines with it, and forms a substance known by the name of prussic acid. Ammonia is not acted on by azote; but it combines rapidly with muriatic acid; the two gases concreting into the solid salt called muriate of ammonia. Ammonia does not combine with the metals; but it changes some of them into oxydes, and then dissolves them. Liquid ammonia is capable of dissolving the oxydes of silver, copper, iron, tin, nickel, zinc, bismuth, and cobalt. When digested upon the oxydes of mercury, lead, or manganese, it is decomposed, water is formed by the union of the hydrogen of the ammonia with the oxygen of the oxydes, and azotic gas is emitted. If a considerable heat be applied, nitric acid is formed at the same time with water. Several other oxydes are also partly deoxidized, when ammonia is poured into their solutions in acids. See ALKALI, CHEMISTRY, &c.

AMMONIAC, in chemistry, a gum resin brought from the East Indies. It is supposed to be a species of the Ferula. It is in small pieces agglutinated together, and has a yellowish white colour. Its smell is like that of the galbanum, but more pleasant. Its taste is a nauseous sweet mixed with bitter. It does not melt. Water dissolves a portion of it; the solution is milky, but gradually lets fall a resinous portion. One-half is soluble in alcohol. Its specific gravity is 1.2. Neither alcohol nor water, distilled off it, brings over any thing.

AMMONITRUM. See GLASS.

AMMOPHILA, in natural history, the *sand-wasp*, a genus of insects of the order Hymenoptera: gen. char. snout conic, inflected, concealing a bifid retractile tubular tongue: jaws forcipated, three-toothed at the tip; antennæ filiform in each sex, with about 14 articulations: eyes oval: wings plain: sting pungent, concealed in the abdomen. This genus is separated from that of the sphex, on the authority of the Rev. Mr. Kirby: in their manners and economy they resemble each other; and it is probable that many more of the spheges might with propriety be removed into this genus. There are four species: A. vulgaris inhabits Europe, in sandy, sunny banks, where it digs a hole with its fore-feet, and buries the carcase of the larva of a moth or half dead spider, in the body of which it has deposited its eggs, and then covers up the orifice.

AMMUNITION, a general term for all warlike provisions, but more especially powder, ball, &c.

Ammunition, arms, utensils of war,

gun-powder, imported without licence from his Majesty, are, by the laws of England, forfeited, and triple the value.

And again, such licence obtained, except for furnishing his majesty's public stores, is to be void, and the offender to incur a præmunire, and to be disabled to hold any office from the crown.

AMNESTY, in matters of policy, an act, by which two parties at variance promise to pardon and bury in oblivion all that is past.

Amnesty is either general and unlimited, or particular and restrained, though most commonly universal, without conditions or exceptions; such as that which passed in Germany at the peace of Osnaburg in the year 1648.

Amnesty, in a more limited sense, denotes a pardon granted by a prince to his rebellious subjects, usually with some exceptions: such was that granted by Charles II. at his restoration.

AMNIOS, in anatomy, a thin pellucid membrane, which surrounds the fœtus.

The fœtus in the uterus is enveloped in a peculiar membranaceous covering, to which anatomists have given the name of amnios. Within this there is a liquid, distinguished by the name of the liquor of the amnios, which surrounds the fœtus on every part. This liquid, as might have been expected, is very different in different animals; at least the liquor amnii in women and in cows, which alone have hitherto been analysed, have not the smallest resemblance to each other. The liquor of the amnios of women is a fluid of a slightly milky colour, a weak pleasant odour, and a saltish taste. The white colour is owing to a curdy matter suspended in it, for it may be obtained quite transparent by filtration. Its specific gravity is 1.005. It gives a green colour to the tincture of violets, and yet it reddens very decidedly the tincture of turnsole. These two properties would indicate at once the presence of an acid and of an alkali. It froths considerably when agitated. On the application of heat it becomes opaque, and has then a great resemblance to milk diluted with a large quantity of water. At the same time it exhales the odour of boiled white of egg. Acids render it more transparent. Alkalies precipitate an animal matter in small flakes. Alcohol likewise produces a flaky precipitate, which, when collected and dried, becomes transparent and very like glue. The infusion of nut galls produces a very copious brown coloured precipitate. Nitrate of silver occasions a white precipitate, which is insoluble in nitric acid, and consequently is muriate of silver. The liquor of the amnios of the cow has a viscidity similar to mucilage of gum arabic, a brownish red colour, an acid and bitter taste, and a peculiar odour, not unlike that of some vegetable extracts. Its specific gravity is 1.028. It reddens the tincture of turnsole, and therefore contains an acid. Muriate of barytes causes a very abundant precipitate, which renders it probable that it contains sulphuric acid. Alcohol separates from it a great quantity of a reddish coloured matter. The animal matter possesses the following properties: It has a reddish brown colour and a peculiar taste; it is very soluble in water, but insoluble in alcohol, which has the property of separating it from water. When exposed to a strong heat, it swells, exhales first the odour of burning gum, then of empyreumatic oil, and of ammonia, and at last the peculiar odour of prussic acid becomes very conspicuous. It differs from gelatine in the viscidity which it communicates to water, in not forming a jelly when concentrated, and in not being precipitated by tannin. It must be therefore ranked among the very undefined and inaccurate class of animal mucilages. When burnt, it leaves a large portion of coal, which is readily incinerated, and leaves a little white ashes, composed of phosphate of magnesia, and a small proportion of phosphate of lime.

AMOMUM, in botany, a genus of the Monandria Monogynia class and order, the characters of which are, that the calyx is a perianthium, one-leafed, cylindraceous, and unequally trifid; the corolla is monopetalous and funnel-shaped, tube cylindraceous, border three-parted, parts oblong and spreading; the nectary two-leaved or two-lipped, lower lip inserted under the upper segment of the corolla, spreading almost erect, entire or three-lobed; the stamina have no filament, except the upper lip of the nectary smaller than the lower, and opposite to it, accuminate or three-lobed at the tip; along the middle or at the end of which grows longitudinally a large oblong anther, germinate, or divided by a longitudinal furrow into two, which are one-valved; the pistillum has an inferior, oblong germ, style filiform, drawn through the suture of the anther, stigma turbinate, obtuse and ciliate; the pericarpium a fleshy capsule, ovate, three-cornered, three-celled, and three-valved; the seeds are several, covered with a sort of

berried aril. Gmelin, in his edition of Linnæus, enumerates twenty species. A. zinziber, narrow-leaved ginger, cultivated by Miller, and flowering in September, is a native of the East Indies, and other countries of Asia, and is much used there and in the West Indies. The dried roots furnish a considerable article of commerce from our West India islands; they are of great use in the kitchen and in medicine, and when preserved green as a sweet-meat are preferable to every other sort. A. zerumbet, cultivated at Hampton-court, in 1690, and flowering with us from September to November, when the stalks perish like those of the true ginger; a native of the East Indies, Cochinchina, &c. and also in Otaheite, and the other Society Isles. This is used externally in the East, in cataplasms and fomentations; but not internally, as spice or medicine; though Garcias says, that it makes a better preserve with sugar than the other. As to the propagation and culture of these plants, it may be observed, that they are tender, and require a warm stove to preserve them in this country. They are easily propagated by parting their roots, which should be done in the spring, before they put out new shoots, in parting the roots, they must not be divided into small pieces, especially if they are designed to have flowers; nor should they be planted in very large pots. They thrive best in a light rich earth, such as that of the kitchen garden; and with this the pots should be filled within two inches of the top, and the roots should be placed in the middle of the pots, with their crowns upwards, and the pots should then be filled with the same earth; they should be plunged into a hot-bed of tanner's bark, and sparingly watered, till their stalks appear above ground, when they will admit of more moisture, especially in the summer months; but in autumn, the waterings must not be frequent nor plentiful, and during winter very sparing. The pots must constantly remain plunged in the tan-bed; for if they are taken out and placed on shelves in the stove, their fibres often shrink, and thus their roots decay. By this management these plants have greatly multiplied, and the common ginger has produced roots, weighing five or six ounces; but the others have been nearly a pound weight. In the West Indies the ginger thrives best in a rich cool soil; in a more clayey soil the root shrinks less in scalding. The land laid out for the culture of it is first well cleared and hoed, and then slightly trenched, and planted in March or April; it flowers about September; and when the stalks are wholly withered, the roots are fit to be taken up, which is generally done in January and February.

AMONTONS (William), in biography, an ingenious French experimental philosopher, was born in Normandy the 31st of August, 1663. While at the grammar school, he by sickness contracted a deafness that almost excluded him from the conversation of mankind. In this situation he applied himself to the study of geometry and mechanics, with which he was so delighted, that it is said he refused to try any remedy for his disorder, either because he deemed it incurable, or because it increased his attention to his studies. Among other objects of his study were, the arts of drawing, of land-surveying, and of building; and shortly after he acquired some knowledge of those more sublime laws by which the universe is regulated. He studied with great care the nature of barometers and thermometers; and wrote his treatise of "Observations and experiments concerning a new Hour-glass, and concerning Barometers, Thermometers, and Hygroscopes;" as also some pieces in the Journal des Savans. In 1687, he presented a new hygroscope to the Academy of Sciences, which was much approved. He found out a method of conveying intelligence to a great distance in a short space of time; this was by making signals from one person to another, placed at as great distances from each other as they could see the signals by means of telescopes: this was unquestionably done upon the principle of modern telegraphs, which were brought into general use in 1794, almost a century after the death of Amontons. Amontons was chosen a member of the Royal Academy in 1699, as an eleve under the third astronomer; and he read there his "New Theory of Friction," in which he happily cleared up an important object in mechanics. He had a particular genius for making experiments; his notions were just and delicate: he knew how to prevent the inconveniences of his new inventions, and had a wonderful skill in executing them. He died of an inflammation in his bowels, the 11th of October, 1705, being only 42 years of age. His pieces are contained in the different volumes of the memoirs of the Academy of Sciences; these are numerous, and upon various subjects, as the air, action of fire, barometers,

thermometers, hygrometers, friction, machines, heat, cold, rarefactions, pumps, &c. They may be seen in the volumes for the years 1696, 1699, 1702, 1703, 1704, and 1705. The character of Amontons for integrity, modesty, and candour, was no less distinguished than his talents and genius in philosophical pursuits. Upon his death in 1705, M. Fontenelle delivered an elegant and impressive eulogium on his merits. See MEMOIRS of the Academy for that year.

AMORPHA, in botany, *bastard indigo*, a genus of plants belonging to the Diadelphia Decandria class of Linnæus; the flower of which consists of one petal, vertically ovated, hollow, and erect; and the fruit is a lunulated pod, of a compressed form, and covered with tubercles, in which are contained two seeds, of an oblong kidney-like shape. There are two species.

This shrub grows naturally in Carolina, where formerly the inhabitants made a coarse sort of indigo, which occasioned its name of the bastard indigo. It rises with many irregular stems to the height of twelve or fourteen feet, with very long winged leaves. It was observed by Thunberg in the island of Niphon, belonging to Japan, but is now become very common in the gardens and nurseries near London, where it is propagated as a flowering shrub. It is propagated by seeds sent from America.

AMPELIS, in natural history, the *chatterer*, a genus of birds of the order Passeres, bill straight, convex, subincurved, each mandible notched: nostrils covered with bristles: tongue sharp, cartilaginous, bifid: middle toe connected at the base to the outside. There are, according to Gmelin, fourteen species: we shall notice the following: A. garrulus, or waxen chatterer; a beautiful bird about eight inches long. Its bill is black, and has a small notch at the end; its eyes are placed in a band of black, which passes from the base of the bill to the hinder part of the head. Its throat is black; its feathers on the head are long, forming a crest; all the upper parts of the body are of a reddish ash colour; the breast and belly inclining to purple; the tail feathers are black, tipped with pale yellow; the quills are black, the third and fourth tipped on their outer edges with white: the five following with straw colour, but in some bright yellow; the secondaries are tipped with white, each being pointed with a flat horny substance of a bright vermilion colour. These appendages vary in different subjects. This rare bird visits our island only at uncertain intervals. Their summer residence is supposed to be in the northern parts of Europe, within the arctic circle, whence they spread themselves into other countries, where they remain during the winter, and return in the spring to their usual haunts. The food of this bird is berries of various kinds; in some countries it is said to be extremely fond of grapes. Only this species of the chatterer is found in Europe, the others are natives of America. See plate I. Aves, fig. 5. A. carunculata, has a black bill, with a pendulous, expansile, moveable caruncle at the base, inhabits Cayenne and Brazil, and is about twelve inches long. The bill is an inch and a half long, and black; at the base is a fleshy carbuncle hanging over it, like that of a turkey cock. The female is furnished with one as well as the male. These birds are said to have a very loud voice, to be heard half a league off, which is composed of merely two syllables *in*, *an*, uttered in a drawling tone; but some have compared it to the sound of a bell. A. Americana, cedar bird: this has been considered by the European naturalists as a mere variety of their chatterer; but Mr. Wilson has shewn it to be a distinct species.

AMPELITES, *cannel-coal*, a hard, opaque, fossil, inflammable substance, of a black colour. The ampelites, examined by a microscope, appears composed of innumerable very small thin plates, laid closely and firmly upon one another, and full of very small specks, of a blacker and more shining matter than the rest. There is a large quarry of it in Alençon, in France. It is dug also in many parts of England; but the most beautiful is found in Lancashire and Cheshire: it lies usually at considerable depth. It is capable of a very fine polish, and is made into trinkets, and will pass for jet. Husbandmen dress their vines with it, as it kills the vermin which infest them: it is likewise used for dying the hair black.

AMPHIBIA, in natural history, a class of animals that live either on land or in water. The title Amphibia, applied to this class of animals by Linnæus, may perhaps be considered as not absolutely unexceptionable, the power of living with equal facility both in land and water being not granted to all the animals which compose it; yet, since it is certain that the major part are found to possess that faculty in a considerable degree, the title may be allowed to continue. The Am-

phibia, from the peculiar structure of their organs, and the power which they possess of suspending respiration at pleasure, can not only support a change of element uninjured, but can also occasionally endure an abstinence, which would infallibly prove fatal to the higher order of animals. It has been a general doctrine among anatomists, that the hearts of the Amphibia were, in the technical phrase, unilocular, or furnished with only one ventricle or cavity; a doctrine maintained by many eminent anatomists, and, in general, assented to by the greatest physiologists, as Boerhaave, Haller, &c. &c. and only occasionally called in question, on viewing in some animals of this tribe a seemingly different structure. Thus the French academicians of the seventeenth century pronounce the heart of an Indian land tortoise, which they examined, to have in reality three ventricles instead of one. Linnæus, in his Systema Naturæ, acquiesces in the general doctrine, and accordingly makes it a character of this class of animals. Among later physiologists, however, there are not wanting some who think it more correct to say, that the hearts of the Amphibia are in reality double, or furnished with two ventricles, with a free or immediate communication between them. The lungs of the Amphibia differ widely in their appearance from those of other animals; consisting, in general, of a pair of large bladders or membranaceous receptacles, parted, in the different species, into more or fewer cancelli, or subdivisions, among which are beautifully distributed the pulmonary blood-vessels, which bear but a small proportion to the vesicular part through which they ramify; whereas, in the lungs of the Mammalia, so great is the proportion of the blood-vessels, and so very small are the vesicles, or air-cells, that the lungs have a fleshy rather than a membranaceous appearance. In the Amphibia, therefore, the vesicular system may be said greatly to prevail over the vascular; and in the Mammalia, or warm-blooded animals, the vascular system to prevail over the vesicular. Many of the Amphibia are possessed of a high degree of reproductive power, and will be furnished with new feet, tails, &c. when those parts have by any accident been destroyed. Many are highly beautiful in their colours, as well as elegant in their forms; while others, on the contrary, are, in the common acceptation of the words, extremely deformed, and of unpleasing colours. Their bodies are sometimes defended by a hard, horney shield, or covering; sometimes rather by a coriaceous integument; sometimes by scales; and sometimes have no particular defence or coating, the skin being merely marked by soft, pustular warts, or protuberances, more or less visible in the different species. The bones of the Amphibia, except in a very few instances, are of a more cartilaginous nature than in either the Mammalia or Birds: many species are destitute of ribs, while others have those parts very numerous: some are furnished with formidable teeth; others are toothless: some are fierce and predacious; others inoffensive. Few, except among the serpent tribe, are of a poisonous nature, the general prejudice against them having arisen rather on account of their form, than from any real poisonous quality; but among the serpents, we meet with some species possessed of the most dreadful poison, as well as with the power of applying it with fatal force to the animals which they attack. The number of poisonous serpents is, however, not so great as was formerly imagined; perhaps not more than a sixth part of the whole number of known species being of that character. Among no animals do we meet with beings of a more singular form than the Amphibia; some of which present appearances so unusual, so grotesque, and so formidable, that even the imagination of the poet or painter can hardly be supposed to exceed the realities of nature. The amphibia in general are extremely tenacious of life, and will continue to move, and exert many of their animal functions, even when deprived of the head itself. The experiments which have been occasionally made on these subjects can hardly be recited without horror. The natural life of some of the Amphibia, more particularly of the tortoise tribe, is extremely long; and even to the smaller tribes of frogs and lizards, a considerable space seems allotted. The same is also highly probable with respect to the serpent tribe. By far the major part of the Amphibia are oviparous, some excluding eggs covered with a hard or calcareous shell, like those of birds; others, such as are covered only with a tough skin, resembling parchment; and in many, they are perfectly gelatinous, without any kind of external covering, as it the spawn of the common frog. Some few are viviparous; the eggs first hatching internally, and the young being afterwards excluded in their perfect form, as in the viper, &c. &c. In cold and tempe-

rate climates, most of the Amphibia pass the winter in a torpid state; and that sometimes in a degree of cold which would seem but ill calculated for the preservation of animal life. The common large water-newt, in particular, is said to have been occasionally found completely embedded in large masses of ice, in which it must have remained inclosed for a very considerable period; and yet, on the dissolution of the ice, has been restored to life. The Amphibia may be divided into four distributions, viz. Testudines, Ranæ, Lacertæ, and Serpentes; or Tortoises, Frogs, Lizards, and Serpents. The animals belonging to the three former of these divisions constitute the order entitled Reptilia, containing the Amphibia Pedata, or Footed Amphibia. The last division, or that of Serpents, constitutes the order Serpentes; containing the Amphibia Apoda, or Footless Amphibia.

AMPHITRITE, a genus of worms, of the order Molusca; body projecting from a tube, and annulate; peduncles or feet small, numerous; feelers two, approximate, feathered; no eyes. There are seven species: of which the A. reniformis, with a rounded body and simple feelers, is three inches long, and inhabits the seas about Iceland. The body is of a most beautiful red; head defended by two semicircular arches; plumes fourteen, and alternately red and white; annulations of the body from 80 to 90, with each a minute tubercle on each side; tail pointed, and not jointed; tube red, tough, coriaceous, simple, and four inches long.

AMPHISBÆNA, in natural history, a genus of Serpents, of which the generic character is, body cylindric, equal; annular divisions on body and tail. According to Gmelin there are five species; but Dr. Shaw mentions two only, viz. the Alba and the Fuliginosa. The whole genus is allied to that of the Anguis, and in some degree to the Lacerta: it is, however, readily distinguished by the manner in which the exterior surface of its skin is marked in well-defined numerous circles or rings, completely surrounding the body, and divided in a longitudinal direction by still more numerous straight lines, thus forming so many square or parallelogramic scales. The alba is about 18 or 20 inches long, and of a proportional thickness. The head, which is covered with large scales, being but little larger in diameter than the body; the tail is short, terminating in a rounded extremity. The colour is, as the name imports, white, though in some instances it is tinged with a pale rose colour. The usual number of circles in this snake is about 223 on the body, and 16 on the tail. It is a native of South-America, where it is found in woods, preying on insects and worms. It is a harmless animal, but on being handled, it excites a slight itching on the skin, accompanied by small pustules, owing to an acrimonious moisture exuding from the animal. A. fuliginosa is at all times readily distinguished by its colours. There are about 230 rings on its body and tail. It is white, variegated with black or deep brown spots. The head is without spots. It is found in many parts of South-America, resembling the albā in its manners, and being equally innoxious. The skin of the amphisbæna is remarkably strong and tenacious, and of a smooth or glossy surface: it is supposed to be able to perforate the ground with great facility, in the manner of earth worms, to obtain its food. The other species are found in America. See plate Serpentes, fig 2.

AMPLITUDE, in astronomy, an arch of the horizon intercepted between the east or west point thereof, and the centre of the sun, star, or planet, at its rising and setting, and so is either north or south.

If the amplitude be taken from the rising sun, or star, it is called its rising or ortive amplitude; if, when it sets, its setting or occasive amplitude. The sun's amplitude, either rising or setting, is found by the globes, by bringing the sun's place to the horizon, either on the east or west side, and the degrees from the east point, either north or south, are the amplitude required. To find the amplitude trigonometrically, say, as the cosine of the latitude : radius : : sine of the present declination : sine of the amplitude. This problem is useful in navigation, to find the variation of the compass. Thus in latitude 51° 31′, when the sun's declination is 23° 28′, then we say,

As 60. S. 51° 31′, : 10. &c. :: S. 28° 28′ : S. Amp. or, as 9.793990 : 10. &c: : : 9.600118 : 9.806127 = sine of 39° 47′ = the amplitude sought: that is, the sun then rises or sets 39° 47′ from the east or west point to the north or south, as the declination is either north or south.

Amplitude, *magnetical*, the different rising or setting of the sun, from the east or west points of the compass. It is found by observing the sun, at his rising and setting, by an amplitude compass. The difference between the magnetical amplitude and the true amplitude is the varia-

tion of the compass. If the magnetical amplitude be found to be . . . . 61° 55′
at the time it is computed as above
to be . . . 39° 47′

then the difference 22° 8′
is the variation westward.

Amplitude *of the range of a projectile*, the horizontal line subtending the path in which the projectile moved. See Projectile.

AMPUTATION, in surgery, the cutting off a limb, or other part of the body, with an instrument.

AMULET, a charm, or preservative against mischief, witchcraft or diseases. Amulets were made of stone, metal, simples, animals, and, in a word, of every thing which fancy or caprice suggested; and sometimes they consisted of words, characters, and sentences, ranged in a particular order, and engraved upon wood, &c. and worn about the neck, or some other part of the body. At other times they were neither written nor engraved, but prepared with many superstitious ceremonies, great regard being usually paid to the influence of the stars. The Arabians have given to this species of amulet the name of talisman.

All nations have been fond of amulets; the Jews were extremely superstitious in the use of them, to drive away diseases: and the Misna forbids them, unless received from an approved man, who had cured at least three persons before, by the same means.

Even among the Christians of the early times, amulets were made of the wood of the cross, or ribbands with a text of scripture written in them, as preservatives against diseases; and therefore the council of Laodicea forbids ecclesiastics to make such amulets, and orders all such as wore them to be cast out of the church.

AMYGDALOID. See Traps Transition.

AMYGDALUS, in botany, a genus of the Polyandria Monogynia class and order; its characters are, that the calyx is a perianthium, one-leaved, tubulous, inferior, quinquefid, deciduous, divisions spreading and obtuse; the corolla of five petals, oblong-ovate, obtuse, concave, inserted into the calyx; the stamina have filaments about 30, filiform, erect, shorter by half than the corolla, inserted into the calyx; anthers simple; the pistillum has a roundish, villose germ, simple style, of the length of the stamens, and headed stigma; the pericarpium is a roundish, villose, large drupe, with a longitudinal furrow; the seed is a nut, ovate, compressed, acute, with prominent sutures on each side, reticulated with furrows, and dotted with small holes. The nut of the almond is covered with a dry skin; that of the peach with a small pulp. There are seven species, of which we shall notice, 1. A persica, with all the serratures of the leaves acute, and the flowers sessile and solitary. There are two varieties, viz. the peach-tree, with downy fruit, and the nectarine, with smooth fruit. 2. A. communis, the almond tree, with the lower serratures of the leaves glandulous, and the flowers sessile and in couplets. The common almond has leaves which resemble those of the peach, but the lower serratures are glandular; they proceed from buds, both above and below the flowers, and not, as in the peach, from the ends of the shoots above and not below the flowers. The form of the flower is not very different; but they usually come out in pairs, and vary more in their colour from the fine blush of the apple-blossom to a snowy whiteness. The chief obvious distinction is in the fruit, which is flatter, with a coriaceous covering, instead of the rich pulp of the peach and nectarine, opening spontaneously when the kernel is ripe. The shell is not so hard as in the first species, and is sometimes tender and very brittle; it is flatter, smoother, and the furrows or holes are more superficial. This tree is a great object in some parts of Italy, and in the south of France; and there are large plantations of it in Provence and Dauphine. It is common in China, and most of the eastern countries; and also in Barbary, where it is a native. In the time of Cato it seems not to have been cultivated in Italy; for he calls the fruit nuces Græcæ, or Greek nuts. With us it is valuable as an ornamental tree in clumps, shrubberies, &c. within view of the mansion; for it displays its delicate red-purple bloom in the month of March, when few other trees have either leaves or flowers. An almond tree, covered with its beautiful blossoms, is one of the most elegant objects in nature. In a forward spring they often appear in February; but in this case the frost generally destroys them, and they bear little or no fruit; but when they flower in March, they seldom fail to bear plenty of fruit, very sweet, and fit for the table when green; but they will not keep long. The amygdalus, or almond-tree is cultivated both for the advantage of the fruit, and as being highly

ornamental in shrubberies, plantations, and other descriptions of pleasure ground, from its coming into bloom early in the spring. It is, however less important in the former than the latter point of view, as the fruit is often liable to miscarry in this climate. All the species and varieties of this tree are deciduous, and of a hardy nature, thriving well in most common garden soils. Those of the tree kind frequently rise to fifteen or twenty feet in height, dividing into many spreading branches, which ultimately form beautiful heads, that are generally well adorned in the beginning of March with innumerable flowers, which continue in full bloom for a fortnight or three weeks, and are followed by the leaves, which are long and narrow, and the fruit takes its growth. This is downy, rather large, and of an oval form; consisting of a thick, tough, leathery substance, that embraces an oblong nut or stone, in which the kernel or almond is inclosed, which is the only part of the fruit that is capable of being made use of. The dwarf, shrubby sorts of this tree do not, however, in general exceed three or four feet in height, having slender stems, which send forth a great number of small branches near to the ground; and in the single-flowered kind various suckers are frequently sent up from the root. And in both the double and single-flowered almond-tree, all the young branches are thickly beset with flowers in the spring, which, from their having a fine pale red colour, and continuing some time in blow, are highly ornamental. The single sort have their flowers coming out about the end of March, and the double kind in the beginning of April, each remaining about a fortnight in blow. The sorts chiefly cultivated for use in this country are, according to Mr. Forsyth, the tender-shelled almond, the sweet almond, the common or bitter almond, the sweet Jordan almond, and the hard-shelled almond. Those propagated only for ornament are, the dwarf and the double-flowering almonds.—Amygdalus Persica, or peach-tree. Its native country is not known. It came to the Romans from Persia, as its Latin name, *malus Persica*, indicates: and it has been cultivated from time immemorial in most parts of Asia; it has been adopted by almost every nation of Europe, and now flourishes abundantly in America, where it has been introduced by the Europeans. Of this tree we have only one distinct species; but there are a great many varieties, and by producing them from the seed or kernel, they may be almost indefinitely increased. But though they are capable of being greatly augmented in this manner, it is probable that but very few possess the necessary qualities, as nursery-men seldom cultivate more than twenty or thirty sorts. As in the cultivation of this sort of tree much expense is constantly required in walls or other suitable buildings, none but such as produce fine fruit should be attended to. This sort of trees will grow to a considerable height as standards; but, in order to produce and ripen fruit, requires the shelter of warm walls. They flower early in the spring in common, the flowers appearing before the leaves, mostly on the shoots of the preceding year, and either singly or in pairs along their sides. They are formed each of five small petals, with many stamina in the middle, and a small round germen, that becomes the peach. The fruit is distinguished into two sorts, the peach and pavie, from the circumstance of the flesh or pulp quitting or adhering to the stone, as in the former it easily separates, while in the latter it adheres firmly. There are various sorts of peaches that may be cultivated; but for small gardens Mr. Forsyth recommends the following as the most suitable: the early avant, small mignonne, the Anne peach, royal George, royal Kensington, noblesse, early Newington, Galland, early purple, chancellor, nivette, the Catharine, the late Newington, Amygdalus nucipersica, or the nectarine tree. This is now generally considered as a variety of the peach; but the two trees cannot by any circumstances in their growth, wood, leaves, or flowers, be distinguished from each other with any degree of certainty. The fruits are, however, readily discriminated in all their different stages of growth, that of the nectarine having a smooth, firm cuticle, or rind, while in the peach it is covered with a soft, downy substance. Besides, the pulp or flesh of the former is much more firm than that of the latter. There are many varieties of the nectarine that may be cultivated; but those that chiefly deserve attention are, the Fairchild's, the violet, the elrouge, the Newington, the Roman, the temple, and the vermash. The white nectarine may also be cultivated, both for the goodness of its fruit, and as being a curious variety.

AMYRIS, a genus of the Octandria Monoginia class and order; its characters are, that the calyx is a perianthium, one-leafed, four-toothed, acute, erect, small, and permanent; the corolla con-

sists of four oblong, concave, and spreading petals; the stamina have awl-shaped, erect filaments; anthers oblong, erect, of the length of the corolla; the pistillum has a germ, superior, ovate, style thickish, of the length of the stamens, and stigma four-cornered; the pericarpium is a drupaceous and roundish berry; and the seed is a round, shining nut. There are thirteen species, of which we shall notice A. sylvatica, with leaves ternate, crinate, and acute. This is an erect, leafy shrub, from two to fifteen feet high, according to the soil and situation, abounding with a turpentine of a strong disagreeable smell; it is found plentifully about Carthagena, in woods near the sea, and flowers in August. A. maritima, small, shrubby, sweet wood, with leaves ternate, crenulated and obtuse. This is a dwarf shrub, yielding a juice like that of the former, but more agreeable, and smelling like rue: the berry is of the size of black pepper, black when ripe, inclosing a globular, brittle nut, in which is a white kernel. Swartz doubts whether the preceding be a distinct species from this. It grows in very barren coppices, in a calcareous rocky soil, both near the sea, and on the interior mountains of Jamaica, Hispaniola, and Cuba, and flowers from June to September. A. gileadensis, balsam of Gilead tree, with leaves ternate, quite entire, and peduncles one-flowered and lateral. This species is a shrub with purplish branches, having protuberant buds loaded with balsamic rosin: the flowers proceed from the same buds by threes; the bracte minute, and slightly bifid. It has been doubted whether this be a distinct species in itself. A. ambrosiaca, with leaves pinnate and petiolate, and panicles crowded and axillary. This is a tree, with a trunk thirty feet high, branching at the top, with branchlets leafy and flowery: leaves alternate, with two or three opposite, ovate leaflets on each side, ending in long points, smooth, entire, on short petioles, gibbous at the base; flowers yellowish white, axillary, and corymbed; perianth very small and four-toothed; petals lanceolate, spreading at the tip; filaments filiform, half as long as the calyx, inserted into the tube; germ superior, subglobose, style cylindrical; stigma capitated, depressed, and four-cornered; fruit ovate, oblique, four-celled, resembling that of the laurel, the nucleus involved in a brittle covering, four-celled, with four stones wrapped up in a viscid red pulp, having a balsamic smell and taste, hardening into a grey rosin, and used for burning as a perfume The whole tree is sweet-scented, and yields a very odoriferous balsam from the wounded trunk or branches, which is used in the dysentery; the dose is one dram in red wine; it is also used in houses and churches for burning as a perfume. It grows in the woods of Guiana, and by the sea-shore; flowering and fruiting in September A. balsamifera, sweet amyris, white candle-wood, or rose-wood, with leaves two-paired. This grows to a considerable size, and is one of the most valuable trees in the island of Jamaica; the wood is white, and of a curled grain when young, but grows of a dirty clouded ash colour with age, bearing a fine polish, and having a pleasant smell; it is heavy, and much esteemed among cabinet-makers. All the parts of this tree are full of warm aromatic particles, and may be used in baths and fomentations: the berries are oblong, and have the taste of the balsam copaiba. An infusion of the leaves has a pleasant flavour, is highly cephalic, strengthens the nerves, and is particularly restorative to weak eyes. In Jamaica there are several species of amyris, the leaves and bark of which yield a fine balsamic juice; and if the body were tapped at the proper season, a thick liquor would transude, resembling that of the Gilead balsam, to which the taste of the bark and wood of the smaller branches bears a very exact relation. Dr. Wright apprehends that this wood, by distillation, would yield a perfume equal to the oleum rhodii.

ANA, among physicians, denotes an equal quantity of the ingredients which immediately precede it in prescriptions: it is written by abbreviation ā or ā ā; thus, ℞ *thur. myrth. alum.* ā ā, ℈ j: that is, take frankincense, myrrh, and alum, each a scruple.

Ana, in matters of literature, a Latin termination added to the titles of several books in other languages.

They are collections of the conversation and memorable sayings of men of wit and learning; the Scaligeriana was the first book that appeared with a title in *ana*, and was afterwards followed by the Perroniana, Thuana, Nudæana, Menagiana, and even by Arlequiniana, in ridicule of all books in *ana*. The Menagiana are accounted the best.

Ana, among occult philosophers, a term used to denote the human mind; from whence some will have *anasapta*, a dæmon invoked by sick persons, to be derived.

ANABASIS, in botany, a genus of the Pentandria Digynia class and order: essen. char.; calyx, three-leaved; cor. five-petalled: berry, one-seeded, surrounded by a calyx: there are four species.

ANACARDIUM, in botany, *acajou*, a genus of the Enneandria Monogynia class and order; its characters are, that it has hermaphrodite flowers, and male flowers, either mixed with the hermaphrodites, or on a distinct tree. The calyx of the former is a perianthium, five-leaved, leaflets ovate, concave, coloured, erect, and deciduous; the corolla has five petals, lanceolate, acute, three times as long as the calyx, upright at bottom, reflex at the end; the stamina have ten filaments, united at the base and upright, nine of them capillary, shorter than the calyx; the pistillum has a germ, kidney-shaped, obliquely emarginate in front, style subulate, bent in, the length of the corolla; stigma small, roundish, depressed and concave: no pericarpium; receptacle fleshy, very large and obovate; the seed a nut, kidney-shaped, large at the top of the receptacle, with a thick shell, cellular within, and abounding in oil. The calyx, corolla, and stamina, of the male flowers, as in the hermaphrodites; the pistillum has either no germ, or one that is abortive. There is one species, viz. A. occidentale, cashew-nut, cassu or acajou. The cashew is an elegant tree, 12 or 16 feet high, spreading much as it rises, and beginning to branch at the height of five feet, according to Browne; but Long affirms that in good soil it spreads to the size of a walnut tree, which it resembles in the shape and smell of the leaves; the trunk seldom exceeds half a foot in diameter; the leaves are coriaceous, subovate, shining, entire, petioled, and scattered alternately; and terminating, containing many small, sweet-smelling flowers, on oblong receptacles, scarcely distinguishable from the peduncle; the corolla red, with commonly 10 stamens, one of which has no anther, but it has frequently eight, or only seven, all fertile; and there are sometimes female flowers, entirely destitute of stamens. The fruit has an agreeable subacid flavour, in some degree restringent; in some of a yellow, and in others of a red colour, which difference may be probably owing to the soil or culture. The juice of the fruit, fermented, affords a pleasant wine; and distilled, yields a spirit exceeding arrack or rum, and serves to make punch, and also to promote urine. The ripe fruit is sometimes roasted and sliced, and thus used for giving an agreeable flavour to punch. The restringency of the juice has recommended it as a remedy in dropsical habits. From one end of the apple proceeds the nut, which is kidney-shaped, inclosed in two shells, the outer of an ash colour, and smooth, and the inner covers the kernel. Between these shells is lodged a thick, inflammable, and very caustic oil, which, incautiously applied to the lips and mouth, inflames and excoriates them. This oil has been successfully used for eating off ring-worms, cancerous ulcers, and corns; but it should be very cautiously applied. Some females have used it as a cosmetic, in order to remove the freckles and tan occasioned by the scorching rays of the sun, but it proves so corrosive as to peel off the skin, and cause the face to inflame and swell; but after enduring the pain of this operation for about a fortnight, thin new skin, as it may be called, appears, fair like that of a new born infant. This oil also tinges linen of a rusty iron colour, that can hardly be got out; and when smeared on wood it prevents decay, and might, therefore, serve for preserving house timber and ships' bottoms. The fresh kernel has a delicious taste, and abounds with a sweet milky juice; it is an ingredient in puddings, &c. and is eaten raw, roasted, and pickled. The negroes of Brazil, who are compelled by their masters, the Portuguese, to eat this nut, for want of other sustenance, obtain relief from this involuntary use of it in various disorders of the stomach. When the kernel is ground with cacao, it improves the chocolate; but if it be kept too long, it becomes shrivelled, and loses its flavour and best qualities. The milky juice of the tree, obtained by tapping or incision, will stain linen of a deep black, which cannot be washed out; but whether this has the same property with that of the eastern anacardium, has not yet been ascertained; for the inspissated juice of that tree is the best sort of lac which is used for staining black in China or Japan.

ANACHRONISM, in matters of literature, an error with respect to chronology, whereby an event is placed earlier than it really happened, in which sense it stands opposite to parachronism.

ANACREONTIC *verse*, in ancient poetry, a kind of verse so called from its being much used by the poet Anacreon. It consists of three feet and a half, usually spondees and iambics, and sometimes anapests; such is that of Horace,

Lydia dic per omnes.

The word anacreontic is sometimes placed at the beginning of convivial songs, glees, &c. denotes a gay hilarity of movement, and a free and easy style of performance.

ANACYCLUS, in botany, a genus of plants of the Syngenesia Polygamia Superflua. Essen. char. receptacle chaffy, seeds crowned with an emarginate margin, those at the ray membranaceous at the sides. There are five species: of which the creticus and orientalis grow naturally in the islands of the Archipelago. They are low plants, whose branches trail on the ground. The first sort has fine cut leaves, like those of chamomile; the flowers are small, white, and grow single, with their heads declining; these are like those of common may-weed. The second has leaves like those of the ox-eye; the flowers are white, and like those of chamomile.

ANAGALLIS, in botany, a genus of plants, belonging to the Pentandria Monogynia class of Linnæus; the flower of which is monopetalous, multifid, and orbicular; the fruit is a globose capsule, containing only one cell, and dividing horizontally into two hemispheres; the seeds are numerous and angular. There are six species.

ANAGRAM, in matters of literature, a transposition of the letters of some name, whereby a new word is formed, either to the advantage or disadvantage of the person or thing to which the name belongs; thus, from Galenus is formed Angelus: from James, Simea; and so of others.

Those who adhere strictly to the definition of an anagram, take no other liberty than that of omitting or retaining the letter *h*, at pleasure; whereas others make no scruple to use *e* for *æ*, *v* for *w*, *s* for *z*, and *c* for *k*; and vice versa.

ANAGYRIS, *bean-trefoil*, in botany, a genus of plants with papilionaceous flowers, the vixillum of which is shorter than any of the other petals, and its fruit an oblong pod, containing kidney-like seeds: to this it is to be added, that three leaves stand on every petal. It belongs to the Diadelphia Decandria class of Linnæus.

According to Martyn, there are three species: viz. the fœtida, cretica, and inodorata. The first grows wild in the South of France, in Spain, Italy, and Sicily; also about Smyrna. It is a shrub that rises 8 or ten feet high, and produces its flowers in April and May, which are of a bright yellow colour, growing on spikes, somewhat like those of the laburnum: the seeds are never perfected in this country. The second is a native of Canada, and some of the islands of the Archipelago, and is very rare in English gardens. The third is an upright shrub, equal to a middle-sized tree: branches hanging down, frequently scandent: a native of the woods of Cochinchina.

These may be propagated by laying down their tender branches in the spring, observing to tongue them in the same manner as the layers of carnations.

ANALCIME, in mineralogy, a species of Zeolite, found crystallized in the cavities of basalt. The primitive form of its crystals is a cube. It is sometimes found crystallized in cubes, whose solid angles are wanting, and three small triangular faces in place of each; sometimes in polyhedrons with twenty-four faces. Specific gravity 2. Colour white, sometimes red. When rubbed, it acquires only a small degree of electricity, and with difficulty. Before the blow-pipe it melts without frothing into a white transparent glass.

ANALEMMA, in geometry, a projection of the sphere on the plane of the meridian, orthographically made by straight lines and ellipses, the eye being supposed at an infinite distance; and in the east or west points of the horizon. See Maps.

Analemma denotes likewise an instrument of brass or wood, upon which this kind of projection is drawn, with an horizon and cursor fitted to it, wherein the solstitial colure, and all circles parallel to it, will be concentric circles; all circles oblique to the eye will be ellipses; and all circles whose planes pass through the eye, will be right lines. The use of this instrument is to shew the common astronomical problems.

ANALOGY, in matters of literature, a certain relation and agreement between two or more things; which in other respects are entirely different; thus the foot of a mountain bears an analogy to the foot of an animal, although they are two very different things.

There is likewise an analogy between beings that have some conformity or resemblance to one another; for example, between animals and plants, and between metals and vegetables; but the analogy is still stronger between two different species of certain animals.

Analogy, among grammarians, is the correspondence which a word or phrase

bears to the genius and received forms of a language.

ANALYSIS, in a general sense, is the resolution of something compounded into its constituent parts. Hence,

ANALYSIS, in chemistry, is the separation of any substance into its constituent parts, with a view of ascertaining their nature, relative proportion, and mode of union. An instance of this kind is to be had in the decomposition of water, by which it is found that the constituent parts are hydrogen and oxygen, in the proportion of fifteen parts of the former, and eighty-five parts of the latter. As every operation in chemistry is attended with a disunion of parts, the formation of new compounds is almost an invariable consequence; hence, the business of analysis is intimately connected with the whole of chemical science, and can be only thoroughly understood by one that is well versed in every branch of chemistry. On so extensive a subject, it is in vain to attempt laying down precise rules for the mode of operation generally. We may, however, observe that a compound, once formed, perpetually acquires the powers of an element, in being able to unite, undecomposed, with other bodies, simple or compounded, in various proportions; and thus to produce new substances, in which the constituent parts often retain their original affinities, and in analysis again separate into their elementary substances. We may refer to nitrate of ammonia, which is a salt composed of nitric acid, ammonia, and water, each of which is itself a compound, but in this particular combination, it acts as an elementary body: thus, nitric acid consists of azote and oxygen: ammonia, of azote and hydrogen: and water, as we have seen, of oxygen and hydrogen: so that, in truth, there are only azote, hydrogen, and oxygen, that enter into the combination of nitrate of ammonia; but in their simple state, they cannot be made to form the salt; it is requisite that the acid, the alkali, and the water, should be first formed, in order to get the neutral salt.

The business of chemical analysis is to resolve a body into its constituent parts; but the first question is, to determine, in every instance of analysis, whether the resolution should proceed to entire separation into real elements, or only into those compounds which act as elements; as in the case referred to, whether the nitrate of ammonia should be resolved into azote, hydrogen, and oxygen; or whether it should not first be reduced into nitric acid, ammonia, and water. The former mode is best calculated for research, the latter for utility; but a mixture of the two methods is commonly adopted, where the proportion and nature of the compound produced has already been fully ascertained by previous experiment. The most rigid proof of the accuracy of analysis is, to be able to produce the same compound, by uniting the identical parts which we have given as its constituents. This can rarely be performed in a manner perfectly satisfactory; but it frequently happens that a substance may be produced that resembles the one analysed, by employing similar constituents, if not the identical substances. This proof even is almost totally wanting in the analysis of organised bodies, whether vegetable or animal, especially when reduced to their ultimate elements, and generally when only separated into their immediate constituents. The agents made use of in analysis are, heat, the electric and galvanic fluids, if they are two fluids, and the application of re-agents or substances, which indicate the parts of the body to be examined.

ANALYSIS, among logicians, is a method of tracing things backward to their source, and of resolving knowledge into its original principles. It is also called the method of resolution, and stands opposed to the synthetic method, or method of composition. The art of this method consists chiefly in combining our perceptions, and classing them together with address; and in contriving a proper expression of our thoughts, so as to represent their several divisions, classes, and relations. This is clearly seen in the manner of computing by figures in arithmetic, but more particularly in the symbols applied in resolving algebraical problems.

ANALYSIS, among mathematicians, the art of discovering the truth or falsehood of a proposition, or its possibility and impossibility. This is done by supposing the proposition, such as it is, true; and examining what follows from thence, until we arrive at some evident truth, or some impossibility, of which the first proposition is a necessary consequence; and from thence establish the truth or impossibility of that proposition.

The analysis of the ancient geometricians consisted in the application of the propositions of Euclid, Apollonius, &c. till they arrived, proceeding step by step, at the truth required. That of the moderns, though not so elegant, must however, be allowed more ready and general. By this

last, geometrical demonstrations are wonderfully abridged, a number of truths are frequently expressed by a single line, and whole sciences may sometimes be learned in a few minutes, which otherwise would be scarcely attained in many years.

Analysis is divided, with regard to its object, into that of finites and infinites. Analysis of infinite quantities, that which is called specious arithmetic. Analysis of infinites, the same with fluxions. See FLUXIONS.

ANALYSIS, in mineralogy, includes the examination of metallic ores, and of the other products of the mineral kingdom. See MINERALS, *analysis of*.

ANALYSIS *of soils*, the means of ascertaining the nature, properties, and proportions of the different materials of which they are composed. The proper execution of this business enables the farmer to form a just estimate of the value of the different parts of his lands, to make the application of ameliorating substances with propriety, and to understand the effects that may be produced by the combinations of different matters. The apparatus necessary for this business are, scales and weights of different sizes; some porcelain, glass, or stone-ware vessels, unglazed; some muriatic and sulphuric acid, alkali, galls, and pure distilled water.

ANAMORPHOSIS, in perspective and painting, a monstrous projection, or representation of an image, on a plane or curve surface, which, beheld at a proper distance, shall appear regular and in proportion.

To delineate an anamorphosis upon a plane: 1. Draw the square A B C D, (Plate I. Miscel. fig. 4,) of a bigness at pleasure, and subdivide into a number of little squares. 2. In this square, called the craticula prototype, let the image to be represented deformed, be drawn. 3. Then draw the line *a b* (ibid. fig. 5.) equal to A B, and divide it into the same number of equal parts as the side of the prototype A B. 4. Erect the perpendicular E V, in the middle of *a b*, so much the longer as the deformity of the image is to be greater. 5. Draw V S perpendicular to E V, so much the shorter as you would have the image appear more deformed. From each point of division draw straight lines to V, and join the points *a* and S by the right line *a* S. 6. Through the points *d e f g* draw right lines parallel to *a b*, then will *a b c d* be the space in which the monstrous projection is to be delineated; this space is called the craticular ectype. Lastly, in every areola, or small trapezium of the space *a*, *b*, *c*, *d*, draw what appears delineated in the correspondent areola of the square A B C D; and thus you will obtain a deformed image, which will appear in just proportion to an eye distant from it the length of F V, and raised above its height V S.

An image may be deformed mechanically, if you place it, having little holes made here and there in it with a needle, against a candle, and observe where the rays going through these holes fall on a plane or curve surface; for they will give the corresponding points of the image to be deformed.

The practical methods of drawing these images is described in the Leipsic Act, for the year 1712, where we have an account of two machines, one for images viewed with a cylindrical, and the other with a conical mirror. The person who has this instrument may take any point at pleasure, and while he goes over the outlines of it with one pen, another traces the anamorphosis.

In the cloister of the Minims at Paris, there are two anamorphoses traced upon two of the sides of the cloister, one representing a Magdalen, and the other St. John writing his gospel. They are so managed, that when viewed directly they appear like a kind of landscape, but from a particular point of sight they appear very distinctly like human figures.

ANANAS. See BROMELIA.

ANAPÆST, in ancient poetry, a foot consisting of two short syllables and one long: such is the word scŏpŭlōs. It is just the reverse of the dactyl.

ANAPHORA, in rhetoric, a verbal figure, whereby one or more words are repeated in the begining of several sentences. This is a lively and elegant figure, and serves very much to engage the attention; for, by the frequent return of the same word, the mind of the hearer is held in an agreeable suspense till the whole is finished. Such is that in the Psalms: "The voice of the Lord is powerful: the voice of the Lord is full of majesty: the voice of the Lord shaketh in the wilderness." Another from Cicero's fine oration against Cataline: "You do nothing, you attempt nothing, you think nothing, but what I not only hear, but also see and plainly perceive."

ANARHICHAS, in natural history, *wolf-fish*, a genus of fishes of the order of Apodes: head rounded, blunt; fore-teeth in each jaw conic, large, divergent, six or more; grinders in the lower jaw and palate rounded; gill-membrane seven-ray-

eel; body roundish, caudal-fin distinct. There are three species. A. lupus, or ravenous wolf-fish, inhabits the northern seas; grows to 15 feet long; it is a most fierce and ravenous fish, and will fasten on any thing within its reach. It feeds on shell-fish, which it grinds to pieces with its teeth, and swallows shells and all: moves slowly with something of a serpentine motion; the grinders are often found fossile, and are called toad-stones; the flesh is good, but not often eaten. The fossile teeth were formerly much esteemed for imaginary virtues, and were set in gold and worn as rings. Notwithstanding the ferocity of this fish, which is as dreadful to the small inhabitants of the water, as the wolf is to those on land, it is sometimes attacked and destroyed by an enemy of far inferior size and strength, viz. the cyclopterus, or lump-fish, which, fastening itself on its neck, adheres immoveably, tormenting it in such a manner as to cause its death. The wolf-fish frequents the deep part of the sea, and in the spring approaches the coast, in order to deposit its spawn among marine plants: the ova are about the size of peas; and the young are of a greenish cast, like that of sea-wrack, among which they reside for some time after their birth. See Plate I. Pisces, fig. 3. A. minor is found in the Greenland seas; and the A. pantherinus inhabits the Northern and Frozen Ocean.

ANARRHINUM, in botany, a genus of the Didynamia Angiospermia class and order: calyx five-leaved; corol with a nectariferous prominence at its base pointing downwards; the upper-lip flat, without palate, and the orifice pervious; capsule two-celled, many-valved. There are five species.

ANAS, in natural history, a genus of birds of the order Anseres. The bill in this genus is strong, broad, flat or depressed, and commonly furnished at the end with an additional piece termed a nail, the edges of the mandibles marked with sharp teeth; nostrils small, oval; tongue broad, edges near the base fringed; toes four, three before and one behind, the middle one the longest. According to Latham, there are 98 species, besides varieties; but Gmelin gives about 120 species.

From the swan downward to the teal, they are all a clean-plumaged beautiful race of birds, and some of them exquisitely so. Those which have been reclaimed from a state of nature, and live dependant on man, are extremely useful to him: under his protection they breed in great abundance, and, without requiring much of his time and care, lead their young to the pool, almost as soon as hatched, where they instantly, with instinctive perception, begin to search for their food, which at first consists chiefly of weeds, worms, and insects; those they sift, as it were from the mud, and for that purpose their bills are admirably adapted. When they are farther advanced in life, they pick up the sodden scattered grain of the farm-yard, which, but for their assiduous searchings, would be lost. To them also are allotted the larger quantities of corn which are shaken by the winds from the over-ripened ears in the fields. On this clean and simple food they soon become fat, and their flesh is accounted delicious and nourishing. In a wild state, birds of various kinds preserve their original plumage; but when tamed, they soon begin to vary, and shew the effects of domestication: this is the case with the tame goose and the duck, which differ as much from the wild of their respective kinds, as they do from each other. We shall notice the following, as among the most interesting of the species:

Anas Cygnus, the wild swan, measures five feet in length, and above seven in breadth, and weighs from thirteen to sixteen pounds. The bill is three inches long, of a yellowish white; from the base to the middle, and thence to the tip, black; the bare space from the bill over the eye and eye-lids is yellow: the whole plumage in adult birds is of a pure white, and next to the skin they are clothed with a thick fine down: the legs are black. This species generally keeps together in small flocks, or families, except in the pairing season, and at the setting in of winter. At the latter period they assemble in immense multitudes, particularly on the large rivers and lakes of the thinly-inhabited northern parts of Europe, Asia, and America: but when the extremity of the weather threatens to become insupportable, in order to shun the gathering storm, they shape their course high in the air, in divided and diminished numbers, in search of milder climates. In such seasons they are most commonly seen in various parts of the British isles, and in other more southern countries of Europe. The same is observed of them in the North American states. They do not, however, remain longer than till the approach of the spring, when they again retire northward to the arctic regions to breed. A few,

indeed, drop short, and perform that office by the way, for they are known to breed in some of the Hebrides, the Orkney, Shetland, and other solitary isles; but these are hardly worth notice: the great bodies of them are met with in the large rivers and lakes near Hudson's Bay, and those of Kampschatka, Lapland, and Iceland. They are said to return to the latter place in flocks of about a hundred at a time in the spring, and also to pour in upon that island from the north, in nearly the same manner, on their way southward, in the autumn. The young which are bred there remain throughout the first year; and in August, when they are in moult, and unable to fly, the natives, taking advantage of this, kill them with clubs, shoot, and hunt them down with dogs, by which they are easily caught. The flesh is highly esteemed by them as a delicious food, as are also the eggs, which are gathered in the spring. The Icelanders, Kamschatdales, and other natives of the northern world, dress their skins with the down on, sew them together, and make them into garments of various kinds: the northern American Indians do the same, and sometimes weave the down as barbers weave the cauls for wigs, and then manufacture it into ornamental dresses for the women of rank, while the larger feathers are formed into caps and plumes, to decorate the heads of their chiefs and warriors. They also gather the feathers and down in large quantities, and barter or sell them to the inhabitants of more civilized nations. Much has been said of the singing of the swan, in ancient times, and many beautiful and poetical descriptions have been given of its dying song. No fiction of natural history, no fable of antiquity, was ever more celebrated, often repeated, or better received; it occupied the soft and lively imagination of the Greeks; poets, orators, and even philosophers, adopted it as a truth too pleasing to be doubted. The dull insipid truth, however, is very different from such amiable and affecting fables; for the voice of the swan, singly, is shrill, piercing, and harsh, not unlike the sound of a clarionet when blown by a novice in music. It is, nevertheless, asserted by those who have heard the united and varied voices of a numerous assemblage of them, that they produce a more harmonious effect, particularly when softened by the murmur of the waters. At the setting in of frosty weather, the wild swans are said to associate in prodigious multitudes, and, thus united, to use every effort to prevent the water from freezing: this they accomplish by the continual stir kept up amongst them; and by constantly dashing it with their extended wings, they are enabled to remain as long as it suits their convenience, in some favourite part of a lake or river which abounds with their food. The swan is very properly entitled the peaceful monarch of the lake: conscious of his superior strength, he fears no enemy, nor suffers any bird, however powerful, to molest him; neither does he prey upon any one. His vigorous wing is as a shield against the attacks even of the eagle, and the blows from it are said to be so powerful as to stun or kill the fiercest of his foes. The wolf or the fox may surprise him in the dark, but their efforts are vain in the day. His food consists of the grasses and weeds, and the seeds and roots of plants which grow on the margins of the water, and of the myriads of insects which skim over, or float on its surface; also occasionally of the slimy inhabitants within its bosom. The female makes her nest of the withered leaves and stalks of reeds and rushes, and lays commonly six or seven thick-shelled white eggs: she is said to sit upon them six weeks before they are hatched. Both male and female are very attentive to their young, and will suffer no enemy to approach them.

Anas olor, or mute swan. The plumage of this species is of the same snowy whiteness as that of the wild swan, and the bird is covered next the body with the same kind of fine close down; but it greatly exceeds the wild swan in size, weighing about twenty-five pounds, and measuring more in the length of the body and extent of the wings. This also differs, in being furnished with a projecting, callous, black, tubercle, or knob, on the base of the upper mandible, and in the colour of the bill, which in this is red, with black edges and tip; the naked skin between the bill and the eyes is also of the latter colour: in the wild swan this bare space is yellow. The swan, although possessed of the power to rule, yet molests none of the other water-birds, and is singularly social and attentive to those of his own family, which he protects from every insult. While they are employed with the cares of the young brood, it is not safe to approach near them, for they will fly upon any stranger, whom they often beat to the ground by repeated blows; and they have been known by a stroke of the wing to break a man's leg. But, however powerful they are with their wings, yet a slight blow on the head will

kill them. The swan, for ages past, has been protected on the river Thames, England, as royal property; and it continues at this day to be accounted felony to steal their eggs. "By this means their increase is secured, and they prove a delightful ornament to that noble river." Latham says, "In the reign of Edward IV. the estimation they were held in was such, that no one who possessed a freehold of less than the clear yearly value of five marks was permitted even to keep any." In those times, hardly a piece of water was left unoccupied by these birds, as well on account of the gratification they gave to the eye of their lordly owners, as that which they also afforded when they graced the sumptuous board, at the splendid feasts of that period: but the fashion of those days is passed away, and swans are not nearly so common now as they were formerly, being by most people accounted a coarse kind of food, and consequently held in little estimation; but the cygnets (so the young swans are called) are still fattened for the table, and are sold very high, commonly for a guinea each, and sometimes for more: hence it may be presumed, they are better food than is generally imagined. This species is said to be found in great numbers in Russia and Siberia, as well as further southward, in a wild state. They are, without an owner, common on the river Trent, and on the salt-water inlet of the sea near Abbotsbury, in Dorsetshire: they are also met on other rivers and lakes in different parts of the British isles. The female makes her nest, concealed among the rough herbage, near the water's edge: she lays from six to eight large white eggs, and sits on them about six weeks (some say eight weeks) before they are hatched. The young do not acquire their full plumage till the second year. It is found by experience that the swan will not thrive if kept out of the water: confined in a court yard, he makes an awkward figure, and soon becomes dirty, tawdry, dull, and spiritless.

Anas Canadensis, or Canada goose, is another useful species, which has been reclaimed from a state of nature, and domesticated and multiplied in many parts of Europe, particularly in France and Germany; and it is not very uncommon in England. It is as familiar, breeds as freely, and is in every respect as valuable as the common goose: it is also accounted a great ornament on ponds near gentlemen's seats. Mr. Pennant, in his Arctic Zoology, gives the following interesting account of the mode of taking the Canada goose in Hudson's bay: "The English of Hudson's bay depend greatly on geese, of these and other kinds, for their support; and, in favourable years, kill three or four thousand, which they salt and barrel. Their arrival is impatiently attended; it is the harbinger of the spring, and the month named by the Indians the Goose Moon. They appear usually at our settlements in numbers, about St. George's Day, O. S., and fly northward to nestle in security. They prefer islands to the continents, as further from the haunts of men. Thus, Marble Island was found, in August, to swarm with swans, geese, and ducks; the old ones moulting, and the young at that time incapable of flying." "The English send out their servants, as well as Indians, to shoot these birds on their passage. It is in vain to pursue them; they therefore form a row of huts made of bows, at musket-shot distance from each other, and place them in a line across the vast marshes of the country. Each hovel, or, as they are called, stand, is occupied by only a single person. These attend the flight of the birds, and, on their approach, mimic their cackle so well, that the geese will answer, and wheel and come nearer the stand. The sportsman keeps motionless, and on his knees, with his gun cocked, the whole time, and never fires till he has seen the eyes of the geese. He fires as they are going from him, then picks up another gun that lies by him, and discharges that. The geese which he has killed he sets up on sticks, as if alive, to decoy others; he also makes artificial birds for the same purpose. In a good day (for they fly in very uncertain and unequal numbers) a single Indian will kill two hundred. Notwithstanding every species of goose has a different call, yet the Indians are admirable in their imitation of every one."—"The vernal flight of the geese lasts from the middle of April until the middle of May. Their first appearance coincides with the thawing of the swamps, when they are very lean. The autumnal, or the season of their return with their young, is from the middle of August to the middle of October. Those which are taken in this latter season, when the frosts usually begin, are preserved in their feathers, and left to be frozen, for the fresh provisions of the winter stock. The feathers constitute an article of commerce, and are sent into England." This is the common wild goose of the United States; cinereous; head and neck black; cheeks and chin

white, also the vent and tail-coverts: it is often tamed, and will breed with the common goose, producing a larger offspring

Anas Anser, or tame goose. To describe the varied plumage and the economy of this well known and valuable domestic fowl, may seem to many a needless task; but to others, unacquainted with rural affairs, it may be interesting. Their predominant colours are white and grey, with shades of ash, blue, and brown: some of them are yellowish, others dusky, and many are found to differ very little in appearance from the wild kind last described—the original stock, whence, in early times, they were all derived. The only permanent mark, which all the grey ones still retain, like those of the wild kind, is the white ring which surrounds the root of the tail. They are generally furnished with a small tuft on the head, and the most usual colour of the males (gander or stag) is pure white: the bills and feet in both males and females are of an orange red. By studied attention in the breeding, two sorts of these geese have been obtained: the less are by many esteemed as being more delicate eating: the larger are by others preferred, on account of the bountiful appearance they make upon the festive board. The average weight of the latter kind is between nine and fifteen pounds; but instances are not wanting, where they have been fed to upwards of twenty pounds; this is, however, to sacrifice the flavour of the food to the size and appearance of the bird, for they become disgustingly fat and surfeiting, and the methods used to cram them up are unnatural and cruel. It is not, however, altogether on account of their use as food that they are valuable; their feathers, their down, and their quills, have long been considered as articles of more importance, and from which their owners reap more advantages. In this respect the poor creatures have not been spared: urged by avarice, their inhuman masters appear to have ascertained the exact quantity of plumage of which they can bear to be robbed, without being deprived of life. Mr. Pennant, in describing the methods used in Lincolnshire, in breeding, rearing, and plucking geese, says, "they are plucked five times in the year; first at Lady-day for the feathers and quills: this business is renewed, for the feathers only, four times more between that and Michaelmas:" he adds, that he saw the operation performed even upon goslings of six weeks old, from which the feathers of the tails were plucked; and that numbers of the geese die when the season afterwards proves cold. But this unfeeling greedy business is not peculiar to one country, for much the same is practised in others. The care and attention bestowed upon the brood geese, while they are engaged in the business of incubation, in the month of April, is nearly the same every where; wicker pens are provided for them, placed in rows, and tier above tier, not uncommonly under the same roof as their owner. Some place water and corn near the nests; others drive them to the water twice a day, and replace each female upon her own nest as soon as she returns. This business requires the attendance of the gozzard (goose-herd) a month at least, in which time the young are brought forth: as soon afterwards as the brood are able to waddle along, they are, together with their dams, driven to the contiguous loughs and fens, or marshes, on whose grassy margined pools they feed and thrive, without requiring any further attendance until the autumn. To these marshes, which otherwise would be unoccupied, (except by wild birds,) and be only useless watery wastes, we are principally indebted for so great a supply of the goose; for in almost every country, where lakes and marshes abound, the neighbouring inhabitants keep as many as suit their convenience; and in this way immense numbers annually attain to full growth and perfection; but in no part of the world are such numbers reared, as in the fens of Lincolnshire, where it is said to be no uncommon thing for a single person to keep a thousand old geese, each of which, on an average, will bring up seven young ones. So far those only are noticed which may properly be called the larger flocks, by which particular watery districts are peopled; and, although their aggregate numbers are great, yet they form only a part of the large family: those of the farm-yard, taken separately, appear as small specks on a great map; but when they are gathered together, and added to those kept by almost every cottager throughout the kingdom, the immense whole will appear multiplied in a ratio almost incalculable. A great part of those which are left to provide for themserves during the summer, in the solitary distant waters, as well as those which enliven the village green, are put into the stubble fields after harvest, to fatten upon the scattered grain: and some are penned up for this purpose, by which they attain to greater bulk; and it is hardly necessa-

ry to observe, that they are then poured in weekly upon the tables of the luxurious citizens of every town in the kingdom. But these distant and divided supplies seem trifling, when compared with the multitudes, which, in the season, are driven in all directions, into the metropolis; the former appear only like the scanty waterings of the petty streamlet; the latter like the copious overflowing torrent of a large river. To the country market towns they are carried in bags and panniers; to the great centre of trade they are sent in droves of many thousands. To a stranger it is a most curious spectacle to view these hissing, cackling, gabbling, but peaceful armies, with grave deportment, waddling along, (like other armies) to certain destruction. The drivers are each provided with a long stick, at one end of which a red rag is tied as a lash, and a hook is fixed at the other: with the former, of which the geese seem much afraid, they are excited forward; and with the latter, such as attempt to stray are caught by the neck and kept in order; or if lame, they are put into an hospital-cart, which usually follows each large drove. In this manner they perform their journies from distant parts, and are said to get forward at the rate of eight or ten miles in a day, from three in the morning till nine at night: those which become fatigued are fed with oats, and the rest with barley. The tame goose lays from seven to twelve eggs, and sometimes more: these the careful housewife divides equally among her brood geese, when they begin to sit. Those of her geese which lay a second time in the course of the summer, are seldom, if ever, permitted to have a second hatching; but the eggs are used for household purposes. In some countries the domestic geese require much less care and attendance than those of this country. The goose has for many ages been celebrated on account of its vigilance. The story of the saving Rome by the alarm they gave, when the Gauls were attempting the Capitol, is well known, and was probably the first time of their watchfulness being recorded, and, on that account, they were afterwards held in the highest estimation by the Roman people. It is certain that nothing can stir in the night, nor the least or most distant noise be made, but the geese are roused, and immediately begin to hold their cackling converse; and on the nearer approach of apprehended danger, they set up their more shrill and clamorous cries. It is on account of this property that they are esteemed by many persons as the most vigilant of all sentinels, when placed in particular situations.

Anas Erythropus, or barnacle of Europe. The barnacle weighs about five pounds, and measures more than two feet in length, and nearly four and a half in breadth. The bill, from the tip to the corners of the mouth, is scarcely an inch and a half long, black, and crossed with a pale reddish streak on each side: a narrow black line passes from the bill to the eyes, the irides of which are brown: the head is small, and as far as the crown, together with the cheeks and throat, white: the rest of the head and neck, to the breast and shoulders, is black. The upper part of the plumage is prettily marbled or barred with blue-grey, black, and white: the feathers of the back are black, edged with white, and those of the wing-coverts and scapulars blue-grey, bordered with black near their margins, and edged with white: the quills black, edged a little way from the tips with blue-grey: the under parts and tail coverts white: the thighs are marked with dusky lines or spots, and are black near the knees; the tail is black, and five inches and a half long: the legs and feet dusky, very thick and short, and have a stumpy appearance. In severe winters, these birds are not uncommon in England, particularly in the northern and western parts, where, however, they remain only a short time, but depart early in the spring to their northern wilds, to breed and spend the summer.

Anas Bernicla, Brent Goose. Brown; head, breast and neck black, the latter with a lateral white spot: tail-coverts and vent white: plentiful on the sea coast of North America in autumn. It is considered by Mr. Wilson as the same with the Barnacle Goose (A. Erythropus.)

Anas molissima, or eider duck. This wild, but valuable, species is of a size between the goose and the domestic duck, and appears to be one of the graduated links of the chain which connects the two kinds. The full-grown old males generally measure about two feet two inches in length, and two feet eighteen in breadth, and weigh from six to above seven pounds. The female is nearly of the same shape, though less than the male, weighing only between five and six pounds; but her plumage is quite different, the ground colour being of a reddish brown, prettily crossed with waved black lines; and in some specimens the neck, breast, and belly, are tinged with ash: the wings are crossed with two bars of white: quills

dark: the neck is marked with longitudinal dusky streaks, and the belly is deep brown, spotted obscurely with black. The eider duck lays from three to five large, smooth, pale, olive-coloured eggs; these she deposits and conceals in a nest, or bed, made of a great quantity of the soft, warm, elastic down, plucked from her own breast, and sometimes from that of her mate. The ground-work or foundation of the nest is formed of bent-grass, sea-weeds, or such like coarse materials, and it is placed in as sheltered a spot as the bleak and solitary place can afford. In Greenland, Iceland, Spitzbergen, Lapland, and some parts of the coast of Norway, the eiders flock together, in particular breeding places, in such numbers, and their nests are so close together, that a person in walking along can hardly avoid treading upon them. The natives of these cold climates eagerly watch the time when the first hatchings of the eggs are laid: of these they rob the nest, and also of the more important article, the down with which it is lined, which they carefully gather and carry off. These birds will afterwards strip themselves of their remaining down, and lay a second hatching, of which also they are sometimes robbed: but it is said, that when this cruel treatment is too often repeated, they leave the place, and return to it no more. The quantity of this valuable commodity, which is thus annually collected in various parts, is uncertain. Buffon mentions one particular year, in which the Icelandic company sold as much as amounted to upwards of eight hundred and fifty pounds sterling. This, however, must be only a small portion of the produce, which is all sold by the hardy natives, to stuff the couches of the pampered citizens of more polished nations. The great body of these birds constantly resides in the remote northern, frozen climates, the rigours of which their thick clothing well enables them to bear. They are said to keep together in flocks in the open parts of the sea, fishing and diving very deep in quest of shell-fish and other food, with which the bottom is covered; and when they have satisfied themselves, they retire to the shore, whither they at all times repair for shelter, on the approach of a storm. Other less numerous flocks of the eiders branch out, colonize, and breed further southward, in both Europe and America: they are found on the promontories and numerous isles of the coast of Norway, and on those of the northern, and the Hebrides or western isles of Scotland, and also on the Fern isles, on the Northumberland coast, which latter is the only place where they are known to breed in England, and may be said to be their utmost southern limit in that quarter, although a few solitary instances of single birds being shot further southward along the coast have sometimes happened.

Anas Marilla, scaup duck, or Blue-bill. This species measures, when stretched out, nearly twenty inches in length, and thirty-two in breadth. The bill is broad and flat, more than two inches long, from the corners of the mouth to the tip, and of a fine pale blue or lead colour, with the nail black: irides bright deep yellow: the head and upper half of the neck are black, glossed with green: the lower part of the latter, and the breast, are of a sleek plain black: the throat, rump, upper and under coverts of the tail, and part of the thighs, are of the same colour, but dull and more inclining to brown. The tail, when spread out, is fan-shaped, and consists of fourteen short, brown feathers. The legs are short, toes long, and as well as the outer or lateral webs of the inner toes, are of a dirty pale blue colour; all the joints and the rest of the webs are dusky. These birds are said to vary greatly in their plumage, as well as size; but those which have come under the author's observation were all nearly alike. The scaup duck, like others of the same genus, quits the rigours of the dreary north in the winter months, and in that season only is met with on various parts of the American shores. It is well known in England.

Anas Clangula, the golden-eye. The weight of this species varies from twenty-six ounces to two pounds. The length is nineteen inches, and the breadth thirty-one. These birds do not congregate in large flocks, they are varied with black and white; head tumid, violet; at each corner of the mouth a white spot. They are frequent in the waters of the United States during the winter, and take their departure northward in the spring. In their flight they make the air whistle with the vigorous quick strokes of their wings; they are excellent divers, and seldom set foot on the shore, upon which, it is said, they walk with great apparent difficulty, and, except in the breeding season, only repair to it for the purpose of taking their repose. The attempts which were made by M. Baillon to domesticate these birds, he informs the Count de Buffon, quite failed of success. See Plate III. Aves, fig. 1 to 5.

ANASARCA, in medicine, a species of dropsy, wherein the skin appears puffed

up and swelled, and yields to the impression of the fingers, like dough See MEDICINE.

ANASTATICA, the *rose of Jericho*, in botany, a genus of the Tetradynamia Siliculosa class of plants, the calyx of which is a deciduous perianthium, consisting of four oval, oblong, concave, erect, and deciduous leaves; its flowers consist of four roundish petals, disposed in the form of a cross; and its fruit is a short bilocular pod, containing in each cell a single roundish seed. There are two species; one is found growing naturally on the coast of the Red sea, in Palestine, and near Cairo, in sandy places. The stalks are ligneous, though the plant is annual. It is preserved in botanic gardens for the variety, and in some curious gardens for the oddness of the plant, which, if taken up before it is withered, and kept entire in a dry room, may be long preserved, and after being many years in this situation, if the root is placed in a glass of water a few hours, the buds of the flowers will swell, open, and appear as if newly taken out of the ground. The second species, called the A. syriaca, is a native of Austria, Steria, Carniola, Syria, and Sumatra. These plants, being annual, can be propagated only by seeds, which rarely ripen in England.

ANATOMY is the art of examining animal bodies by dissection. It teaches the structure and functions of these bodies, and shews nearly on what life and health depend. When these are well understood, a great step is made towards the knowledge and cure of diseases.

It is derived from the Greek verb, *ανατεμνω*, I cut up: yet we do not comhend under it the mere cutting of dead bodies; but every operation, by which we endeavour to discover the structure and use of any part of the body.

As every animal body is the subject of anatomy, we divide it into the *human* and *comparative*. The first of these, which is confined to the human body, forms the subject of the present article; the last, which is extended to the whole animal creation, will be considered under the head of COMPARATIVE ANATOMY. The offices or functions of the various parts of the body are the objects of the science of PHYSIOLOGY: to which article the reader is referred for those subjects.

The limits to which we are confined, by the nature of the present work, will prevent us from entering much into the details of the structure and composition of the human body. We shall present the reader with a general sketch of the subject, as being more suited to the space which this article is allowed to occupy. After a cursory view of the origin and progress of anatomical science, we shall give a general description of the component parts of the human body, and their functions; and proceed in the last place to the more particular enumeration and description of the various organs.

HISTORY OF ANATOMY.

The want of records leaves us in the dark, with regard to the origin of this art; yet it is reasonable to conclude, that, like most other arts, it had no precise beginning. The nature of the thing would not admit of its lying for a time altogether concealed, and of being suddenly brought to light, either by chance, or genius, or industry.

All the studies and arts which are necessary in human life are so interesting and obvious, that man in every situation has always by instinct and common sense turned his thoughts to them and made some progress in the cultivation of them. To talk seriously of the invention of agriculture, architecture, astronomy, navigation, mechanics, physic, surgery, or anatomy, by some particular man, or in one particular country, or at a time subsequent to some prior æra, would be to discover great ignorance of human nature. We might just as well suppose, that, till a certain period of time, man was without instinctive appetites, and without observation and reflection, and that in a happy hour he found out the art of supporting life by taking food. All such arts, in a less or more cultivated state, were, from the beginning, and ever will be, found in all parts of the inhabited world.

The first men who lived must soon have acquired some notions of the structure of their own bodies, particularly of the external parts, and of some even of the internal, such as bones, joints, and sinews; which are exposed to the examination of the senses in the living body.

This rude knowledge was indeed gradually improved by the accidents to which the body is exposed, by the necessities of life, and by the various customs, ceremonies, and superstitions of different nations. Thus, the observance of bodies killed by violence, attention to wounded men, and to many diseases, the various ways of putting criminals to death, the funeral ceremonies, and a variety of such things, must have shewn men, every day, more and

more of themselves; especially as curiosity and self-love would urge them powerfully to observation and reflection.

The brute creation having such an affinity to man, in outward form, motions, senses, and ways of life, the generation of the species, and the effect of death upon the body, being observed to be so nearly the same in both, the conclusion was not only obvious, but unavoidable that their bodies were formed nearly upon the same model. The opportunities of examining the bodies of brutes were so easily procured, indeed so necessarily occured in the common business of life, that the huntsman in making use of his prey, the priest in sacrificing, the augur in divination, and, above all, the butcher, or those who might out of curiosity attend his operations, would have been daily adding to the little stock of anatomical knowledge. Accordingly we find, in fact, that the South-sea islanders, who have been left to their own observation and reasoning, without the assistance of letters, have yet a considerable share of rude or wild anatomical and physiological knowledge. When Omai was in Dr. Hunter's museum, although he could not explain himself intelligibly, it appeared plainly that he knew the principal parts of the body, and something likewise of their uses, and manifested a great curiosity, or desire, of having the functions of the internal parts of the body explained to him; particularly the relative functions of the two sexes, which, with him, seemed to be the most interesting object of the human mind. The poems of Homer likewise shew us that many facts were popularly known in his time; he probably possessed the general information on the subject. The following passages display a knowledge of some of the internal parts of the body:

"Antilochus, as Thoon turn'd him round,
Transpierc'd his back with a dishonest
wound.
The hollow vein that to the neck extends,
Along the chine, his eager jav'lin rends."
Iliad, b. 13.

The stone, which Diomed threw at Æneas, is said to have broken the acetabulum, and to have torn both the ligaments which connect the thigh in its situation. These particulars are not mentioned in Mr. Pope's translation, we therefore cite the original:

Τῳ βαλεν Αινειαο κατ' ισχιον, ενθα τε μηρος
Ισχι ωενςρεφται· κοτυλην δε τε μιν καλεουσι·
Θλασσε δε οἱ κοτυλην, προς δ' ἀμφω ρηξε τενοντε.
Il. 5. l. 305.

From the sources which have been just enumerated was derived the anatomical knowlege of early times. This knowledge was general or popular. *Anatomy*, properly so called, viz. the knowledge of the structure of the body, obtained by dissections expressly instituted for that purpose, is of much more recent origin.

Civilization and improvement of every kind would naturally begin in fertile countries and healthful climates, where there would be leisure for reflection, and an appetite for amusement. It seems now to be clearly made out, that writing, and many other useful and ornamental inventions and arts, were cultivated in the eastern parts of Asia, long before the earliest times that are treated of by the Greek or other European writers; and that the arts and learning of those eastern people were, in subsequent times, gradually communicated to adjacent countries, especially by the medium of traffic. The customs, superstitions, and climates of eastern countries, appear, however, to have been as unfavourable to practical anatomy, as they were inviting to the study of astronomy, geometry, poetry, and all the softer arts of peace. In those warm climates, animal bodies run so quickly into nauseous putrefaction, that the early inhabitants must have avoided such offensive employments as anatomical inquiries, like their posterity at this day. And, in fact, it does not appear, by the writings of the Grecians, Jews, or Phœnicians, that anatomy was particularly cultivated by any of those nations.

The progress of anatomy in the early ages of the world was more particularly prevented by a very generally prevalent opinion, that the touch of a dead body communicated a moral pollution. When we consider the extent and inveteracy of this prejudice, we shall cease to wonder at the imperfect state of anatomical knowledge in the periods now under review. The practice of embalming the bodies of the dead did not at all reconcile the Egyptians to dissections. The person who made the incision, through which the viscera were removed, immediately ran away, followed by the imprecations and even violence of the bye-standers, who considered him to have violated the body of a friend. The ceremonial law of the Jews was very rigorous in this respect. To touch seve-

ral animals which they accounted unclean, subjected the person to the necessity of purifications, &c. To touch a dead body made a person unclean for seven days. "Whosoever (says the Jewish lawgiver) toucheth the body of any man that is dead and purifieth not himself, defileth the tabernacle of the Lord; and that soul shall be cut off from Israel."

In tracing it backwards in its infancy, we cannot go farther into antiquity than the times of the Grecian philosophers. As an art in the state of some cultivation, it may be said to have been brought forth and bred up among them, as a branch of natural knowledge. We discover in the writings of Plato, that he had paid attention to the organization and functions of the human body.

Hippocrates, who lived about four hundred years before Christ and was reckoned the eighteenth in descent from Æsculapius, was the first who separated the professions of philosophy and physic, and devoted himself exclusively to the latter pursuit. He is generally supposed to be the first who wrote upon anatomy. After the restoration of Greek learning, in the fifteenth century, it was so fashionable for two hundred years together, to extol the knowledge of the ancients in anatomy, as in other things, that anatomists seem to have made it a point of emulation, who should be most lavish in their praise; some from a diffidence in themselves; others through the love of detracting from the merit of contemporaries; many from having laboriously studied ancient learning, and having become enthusiasts in Greek literature; but more, perhaps, because it was the fashionable turn of the times, and was held up as the mark of good education and fine taste. If, however, we read the works of Hippocrates with impartiality, and apply his accounts of the parts to what we now know of the human body, we must allow his descriptions to be imperfect, incorrect, sometimes extravagant, and often unintelligible, that of the bones only excepted.

From Hippocrates to Galen, who flourished towards the end of the second century, in the decline of the Roman empire, that is, in the space of six hundred years, anatomy was greatly improved; the philosophers still considering it as a most curious and interesting branch of natural knowledge, and the physicians, as a principal foundation of their art. Both of them in that interval of time, contributed daily to the common stock, by more accurate and extended observations, and by the lights of improving philosophy.

Aristotle, a disciple of Plato, and preceptor of Alexander the Great, is no less entitled to immortality for his immense labours in natural history and comparative anatomy, than as the founder of the Peripatetic philosophy, which for two thousand years held undisputed sway over the whole learned world. He had formed the most enlarged design which perhaps was ever conceived by any man; no less than that of a general and detailed history of all nature, a plan by far too vast for the short life of an individual. The love of science which distinguished Alexander no less than his ambition and thirst for glory, led him to encourage and assist the plans of Aristotle in a manner worthy of so great a prince, of so exalted a genius, and of such magnificent designs. The sum of money which he was thereby enabled to devote to his works on natural history would be almost incredible, did we not consider the traits of greatness which mark every action of Alexander, and were not the circumstance stated by writers of unexceptionable authority. Athenæus, Pliny, and Ælian, concur in representing it at between one and two hundred thousand pounds.

Shortly after the foundation of Alexandria, a celebrated school was established there, to which the Greeks and other foreigners resorted for instruction, and where physic and every branch of natural knowledge were taught in the greatest perfection. Herophilus and Erasistratus, two anatomists of this school, are particularly celebrated in the history of anatomy. They seem to be the first who dissected the human body. At least in the time of Asistotle, who preceded these anatomists by a very short interval, brutes only had been anatomised. It might have been expected that the practice of embalming would afford favourable opportunities of anatomical investigation, but the rude manner in which the body was prepared, and the dread of pollution, prevented all instructive examination. The progress of the science required that anatomists should have subjects, on which careful and deliberate dissection might be prosecuted without fear of interruption. This benefit was obtained through the taste which the princes of that time displayed for the arts and sciences. The Ptolomies inherited, with their share of the empire of Alexder, the love of science, which shone so conspicuously in that monarch. Ptolemy Philadelphus invited to his capital the greatest men of the age; and by collecting books from all parts, at an immense expense, laid the foundation of the magnifi-

cent Alexandrian library. This king and his predecessor seem to have overcome the religious scruples which forbade the touch of the dead body, and gave up to the physicians the bodies of those who had forfeited their lives to the law. Nay, if the testimony of several authors may be believed, Herophilus and Erasistratus dissected several unfortunate criminals alive. There is, however, something in this practice so repugnant to every feeling of humanity, that we ought probably to consider it only as an exaggerated report of the novel practice of dissecting the human subject. The writings of these anatomists have not descended to us: our knoweledge of their progress in anatomy is derived only from a few extracts and notices which occur in the works of Galen; but these prove them to have made great advances in the knowledge of the structure of the human body.

The Romans, in prosecuting their schemes of universal conquest and dominion, soon became acquainted with the Greeks, and the intercourse of the two nations was constantly increasing. Thus the arts, the philosophy, and the manners of the Greeks were introduced into Italy. Military glory and patriotism,, which had formerly been the ruling passion of the Roman people, now gave way in some degree to the soft arts of peace. The leading men of the Roman republic sought the company and conversation of the learned Greeks; thus literature and philosophy were transported from the Greeks to the Romans, and gave rise to the taste and elegance of the Augustan age. In this way did conquered Greece triumph over the unpolished roughness of her conquerors.

Græcia capta ferum victorem cepit, et artes
Intulit agresti Latio.

Although Rome produced orators, poets, philosophers, and historians which may be brought into competition with those of the Greeks, to the eternal disgrace of their empire it must be allowed that their history is hardly embellished with the name of a single Roman who was great in science or art, in painting or sculpture, in physic, or in any branch of natural knowledge. We cannot therefore introduce one Roman into the history of anatomy. Pliny and Celsus were mere compilers from the Greeks. We may account for this apparent neglect of anatomy among the Romans, as well indeed as for its slow progress among the Greeks, from some of their religious tenets, as well as from the notion already mentioned, of pollution being communicated by touching a dead body. It was believed, that the souls of the unburied were not admitted into the abodes of the dead, or, at least, that they wandered for a hundred years along the river Styx, before they were allowed to cross it. Whoever saw a dead body was obliged to throw some earth upon it, and if he neglected to do so, he was obliged to expiate his crime by sacrificing to Ceres. It was unlawful for the pontifex maximus not only to touch a dead body, but even to look at it; and the flamen of Jupiter might not even go where there was a grave. Persons who had attended a funeral were purified by a sprinkling of water from the hands of the priest, and the house was purified in the same manner. If any one (says Euripides, in Iphigenia) pollutes his hands by a murder, by touching a corpse, or a woman who has lain in, the altars of God are interdicted to him.

There was no anatomist or physiologist, of sufficient reputation to attract our notice, from the times of Herophilus and Erasistratus to the age of Galen. This illustrious character was born at Pergamus, in Asia Minor, about the 130th year of the Christian æra. No expense was spared in his education; after the completion of which, he visited all the most famous schools of philosophy which then existed; and afterwards resided chiefly at Rome, in the service of the emperors of that time,.

To all the knowledge which could be derived from the writings of Hippocrates, and the philosophical schools of the time, Galen added the results of his own labours and observations, and compiled from these sources a voluminous system of medicine. It is generally considered that the subjects of his anatomical labours were chiefly brutes; and it is manifest from several passages, that his descriptions are drawn from monkeys. Indeed, he never expressly states that he has dissected the human subject, although he says he has seen human skeletons. He must be accounted the first who placed anatomical science on a respectable footing; and deserves our gratitude for this, that he was the only source of anatomical knowledge for about ten centuries. The science declined with Galen; his successors were contented with copying him; and there is no proof of a dissection of any human body from Galen to the emperor Frederick II. We may observe, that when any man arrives at the reputation of having carried his art far beyond all others, it seems to throw the rest of the world into a kind of despair. Hopeless of being able to improve their art still further, they do nothing. The great man, who was at first only respectable, grows

every day into higher credit, till at length he is deified, and every page of his writings becomes sacred and infallible. This was actually the fortune of Aristotle in philosophy, and of Galen in anatomy, for many ages; and such respect shewn to any man in any age must always be a mark of declining science.

Anatomy experienced the same fate as learning in general on the decline and fall of the Roman empire. The moral and intellectual character of the Romans had been much debassd in the later ages of the empire. Philosophy and science were manifestly degenerating, and their place was supplied by a debased and corrupted theology. The successive irruptions of the northern barbarians accelerated the approaching ruin. The great inundation of the Goths into Italy, in the fifth century, extinguished, with the Roman empire, its laws, manners, and learning, and plunged the world into the depths of ignorance and superstition. The succeeding ten centuries, which have received the appellation of the dark ages of the world, present a melancholy picture to the philosophic observer of human nature; a barren and dreary waste, not enlivened by a single trace of cultivation.

The followers of the Arabian prophet dissipated the little remains of learning that were left in Asia and Egypt. A contempt of all human knowledge, and the religious obligation of extending the Mahometan faith by means of the sword, made these ignorant barbarians the most dangerous and destructive foes to science and the arts. The city of Alexandria, the school of which had been the resort of the learned for centuries, was taken in the year 640, by Amrou, the general of the Caliph Omar; the celebrated library was burnt, with the exception of those books which related to medicine, which the love of life induced the Arabians to spare.

When the Saracens were established in their new conquests they began to discern the utility of learning in the arts and sciences, and particularly in physic. Mahomet had made it death for any Mussulman to learn the liberal arts: this prohibition was gradually neglected, and many of the caliphs distinguished themselves by their love of letters, and the munificent institutions which they founded for the propagation of learning. The Greek authors were collected, translated, and commented on; but there was no improvement nor extension of science made. In anatomy, the Arabians went no further than Galen, the perusal of whose works supplied the place of dissection. They were prevented from touching the dead by their tenets respecting uncleanness and pollution, which they had derived from the Jews

The Arabian empire in the east was overturned by the Turks, who, still more barbarous and illiterate than the Saracens, carried ignorance and oppression wherever they directed their footsteps. They soon destroyed all the institutions which the Saracens had formed for the propagation of science, and threatened Constantinople itself, which still retained the faint and almost dying embers of Greek knowledge. This city was taken and sacked in the middle of the fifteenth century; and the learned Greeks fled for safety to the western nations of Europe, bringing with them the Grecian authors on medicine, and translating them; which works, the invention of printing, that happened about the same time, greatly contributed to disperse throughout Europe. People had now an opportunity of becoming acquainted with the writings of Galen and the ancients, and, by these means, of arriving at the source of that knowledge which they had hitherto obtained only through the channel of the Arabian physicians. The superiority of the former was soon discovered, and the opinions of the Grecian writers were considered, even in anatomy, as unimpeachable.

For the restoration of anatomy, as well as that of science in general, we are indebted to the Italians. But the first men who signalized themselves in this path partook of that blind reverence for the words of Galen, which had reigned universally in medicine since his death, and which concurred with the universally prevailing prejudices of those times, concerning the violation of the dead, to obstruct all advancement of the science. As an instance of the latter circumstance, we may mention a decree of Pope Boniface VIII. prohibiting the boiling and preparing of bones, which put a stop to the researches of Mundinus.

Among the circumstances which contributed to the restoration of anatomy is to be reckoned, the assistance which it derived from the great painters and sculptors of this age. A knowledge of the anatomy of the surface of the body, at least, is essential to the prosecution of these arts. Michael Angelo dissected men and animals, in order to learn the muscles which lie under the skin. A collection of anatomical drawings made by Leonardo da Vinci at this period, is still extant, and, with subjoined explanations, are found in the library of the king. Dr. Hunter bears witness to the minute and accurate know-

ledge which these sketches discover, and does not hesitate in considering Leonardo as the best anatomist of that time.

About the middle of the sixteenth century the great Vesalius appeared. He was born at Brussels, and studied successively at the different universities of France and Italy. Thus he acquired all the knowledge of antiquity. Not contented with this, he took every opportunity of examining the human body, and followed the army of the emperor Charles V. into France for that purpose. Vesalius was the first who maintained that dissection was the proper way of learning anatomy, in opposition to the study of the works of Galen. His extensive researches into the structure of man and animals led him to detect the errors of Galen, which he freely exposed, shewing from many parts of his works, that this great man had described the human body from the dissection of brutes. This conduct, which should have excited the admiration and esteem of his contemporaries, served only to rouse in their minds the base and sordid passions of jealousy and envy. Galen had held an undisputed sway over the minds of men for many centuries. His works were regarded as the only source of anatomical knowledge, and his opinion on medical subjects, like that of Aristotle in philosophy, was resorted to in all disputes as final and decisive proof. The first man who penetrated this intellectual mist, and erected the standard of reason and truth, in opposition to that of prejudice and authority, might naturally expect to encounter the opposition of those who had been contented to go on in the beaten track. The anatomists, who had always held up Galen in their lectures as the source of all information, were indignant that his faults should be discovered and laid open by so young a man as Vesalius. The controversies which arose from this cause were favourable to the progress of anatomy, as the several disputants were obliged to confirm their own opinions, or invalidate those of their opponents, by arguments drawn from dissection.

Vesalius published, at the age of 25, his grand work on the structure of the human body, with numerous elegant figures, supposed to have been drawn by the celebrated Titian. This work contains such a mass of new information, that it may justly be considered as forming an æra in the history of anatomy We cannot help being surprised that so young a man could have investigated the subject so deeply, at a time when dissection was esteemed sacrilegious, and was therefore carried on secretly, with great danger and difficulty. The great reputation of Vesalius procured for him the esteem and confidence of Charles V. who made him his physician, and kept him about his person in all his expeditions. His zeal for science proved the cause of his death: for having opened a person too soon, the heart was seen to palpitate. He was condemned to perform a pilgrimage to Jerusalem; and as he was returning to take the place of anatomical professor at Venice, he was shipwrecked on the island of Zante, and perished of hunger. It would be unjust to pass over unnoticed the names of Fallopius and of Eustachius, who were contemporary with Vesalius, and contributed greatly to the advancement of anatomy. The anatomical plates drawn and engraved by the latter are executed with an accuracy which cannot fail to excite surprise, even in an anatomist of the present day.

From the time of Vesalius, the study of anatomy gradually diffused itself over Europe; insomuch, that for the last hundred and fifty years it has been daily improving by the labour of many professed anatomists in almost every country of Europe.

In the year 1628, our immortal countryman, Harvey, published his discovery of the circulation of the blood. It was by far the most important step that has been made in the knowledge of animal bodies in any age. It not only reflected useful lights upon what had been already found out in anatomy, but also pointed out the means of further investigation; and accordingly we see that, from Harvey to the present time, anatomy has been so much improved, that we may reasonably question if the ancients have been further outdone by the moderns in any other branch of knowledge. From one day to another there has been a constant succession of discoveries, relating either to the structure or functions of our body; and new anatomical processes, both of investigation and demonstration, have been daily invented. Many parts of the body, which were not known in Harvey's time, have since then been brought to light; and of those which were known, the internal composition and functions remained unexplained; and indeed must have remained inexplicable, without the knowledge of the circulation.

The principal facts relating to this subject were known before the time of Harvey: it remained for him to reject the specious conjectures then maintained concerning the blood's motion, and to examine the truth of those facts which were then known, and by experiments to discover those which remained to be detected.

This he did, and thereby rendered his name immortal.

It seems proper in this place to review the several steps which were made in the investigation of this important subject. Hippocrates believed that all the vessels communicated with each other, and that the blood underwent a kind of flux and reflux from and to the heart, like the ebbing and flowing of the sea. The anatomists at Alexandria adopted a wrong but ingenious opinion; as they found the arteries empty, and the veins containing blood, in their dissections, they imagined that the former were tubes for the distribution of air, and gave them that name, which they have retained ever since; and that the veins were the only channels for the blood. Galen ascertained that the blood flowed both by the arteries and veins, though he knew not then its natural course. On the revival of anatomy in Europe, the pulmonary circulation was known to many eminent men. This was certainly the case with Servetus, who fell a sacrifice, on account of his religious opinions, to the savage bigotry and intolerance of Calvin. Fabricius ab Aquapendente, the preceptor of our famous Harvey, particularly described the valves of the veins, the mechanism of which would absolutely prevent the blood from flowing in those vessels towards the extremities. When Harvey returned from his studies in Italy, his attention being excited to the subject, he began those experiments, by which he learned and demonstrated the fact of the circulation. Harvey's first proposition of the subject impresses conviction so strongly on the mind that we are left in perfect astonishment, how a circumstance so luminously evident should have remained so long unobserved. It must be granted, that the heart projects about two ounces of blood into the arteries at every pulse; what then, it may be asked, becomes of this large quantity of blood, unless it circulates? It must be granted that the heart receives that quantity prior to every pulse. From whence is it received, unless the blood circulates? Harvey tied an artery, and the corresponding vein received no blood; he tied a vein, and all its branches, and those of the corresponding artery were choaked with blood, even to the entire obstruction of circulation and motion. But Harvey was not acquainted with the direct communication that exists between these vessels. He imagined that the blood transuded from the arteries into the veins through a spongy substance. Much yet remained to be ascertained by microscopical observations, and subtile anatomical injections and dissections.

As opportunities of dissection became more numerous, the defects of the old writers in anatomy were discovered. Ingenious men, having gone through their education, determined to consult nature for themselves. It is not to be wondered at that errors and deficiencies in anatomy were found in every page of the works of Galen, to say nothing of Hippocrates, since the human body, in his time, could not be consulted for information. The authority of the Greek writers on these subjects was quickly demolished, and anatomy began to be taught from the subject itself. We must not omit the influence, which the writings of our immortal countryman, Bacon, had on the prosecution of natural knowledge, and in every species of reasoning. The philosophy of Aristotle was driven from the pre-eminent station which it had so long occupied, to make room for the only solid and secure method of observation, experiment, and induction. At this time the Academy del Cimento arose in Italy, the Royal Society in London, and the Royal Academy in Paris. From this period, the important doctrine of rejecting all hypothesis, or general knowledge, till a sufficient number of facts shall have been ascertained, by careful observation and judicious experiments, has been every day growing into more credit. The anatomists and phisiologists of these times distinguished themselves by a patient observation of nature itself, and an accurate account of the phænomena which they observed.

After the discovery and knowledge of the circulation of the blood, the next question would naturally be about the passage and route of the nutritious part of the food, or chyle, from the bowels to the blood-vessels. The name of Aselli, an Italian physician, is rendered illustrious by the discovery of the vessels which carry the chyle from the intestines. He observed them full of a white liquor on the mysentery of living animals, and from this circumstance called them milky or lacteal vessels. For many years the anatomists in all parts of Europe were daily opening living animals, either to see the lacteals, or to observe the phænomena of the circulation. In making an experiment of this kind, Pecquet, in France, was fortunate enough to discover the thoracic duct, or common trunk of all the lacteals, which conveys the chyle into the subclavian vein. And now the lacteals having been traced from the intestines to the thoracic duct, and that

duct having been traced to its termination in a blood-vessel, the passage of the chyle was completely made out. The discovery of the absorbent vessels in other parts of the body, where they are known by the name of lymphatics, from the transparent colour of their contents, very soon followed that of the lacteal and thoracic duct. Rudbeck, a Swede, is generally allowed to have been the first who discovered these vessels; but this honour was disputed with him by Bartholin, a learned Dane. By these vessels the old particles of our bodies, which are no longer fit to remain in it, are removed and conveyed into the blood, to be eliminated by the excretory organs

Leeuenhoeck took up the subject of anatomical inquiry, where others had left it. He investigated the minute structure of the body by the help of magnifying glasses; and was thereby enabled to demonstrate the circulation of the blood in the pellucid parts of living animals; the red globules of the blood, and the animalcula of the semen were first observed by this anatomist. Malpighi also directed his attention chiefly to the developement of minute structure; as that of the glands or secretory organs of the body.

About this time anatomy made two great steps, by the invention of injections, and the method of making anatomical preparations. For these we are indebted to the Dutch, particularly Swammerdam and Ruysch. The anatomists of former ages had no other knowledge of the blood-vessels, than what they could collect from laborious dissections, and from examining the smaller branches of them upon some lucky occasion, when they were found more than commonly loaded with red blood. But filling the vascular system with a bright coloured wax, enables us to trace the large vessels with great ease, renders the smaller much more conspicuous, and makes thousands of the very minute ones visible, which, from their delicacy, and the transparency of their natural contents, are otherwise imperceptible. The modern art of corroding the fleshy parts with a menstruum, and of leaving the moulded wax entire, is so exceedingly useful, and at the same time so ornamental, that it does great honour to the ingenious inventor, Dr. Nichols. The method of casting figures in wax, plaister, or lead, is also a great acquisition to anatomy, as it enables us to preserve a very perfect likeness of such subjects as we but seldom meet with, or cannot well preserve in a natural state. The modern improved methods of preserving animal bodies, or parts of them, in spirits, has been of the greatest service to anatomy; especially in saving the time and labour of the anatomist, in the nicer dissections of the small parts of the body. For now, whatever he has prepared with care, he can preserve, and the object is ready to be seen at any time. And, in the same manner, he can preserve anatomical curiosities and rarities of every kind; such as parts that are uncommonly formed; parts that are diseased; the parts of the pregnant uterus, and its contents. Large collections of such curiosities, which modern anatomists are striving every where to procure, are of infinite service to the art; especially in the hands of teachers. They give students clear ideas about many things, which it is very essential to know, and yet, which it is impossible that a teacher should be able to shew otherwise, were he ever so well supplied with fresh subjects.

When anatomy had thus become a clear and distinct science, it was inculcated and taught, in the different nations of Europe, by numerous professors, with a zeal and industry highly honourable to themselves, and useful to mankind. As the prejudices of mankind respecting dissection have in a great measure subsided, the difficulties, which formerly obstructed anatomical researches, have mostly disappeared, and a sufficient quantity of subjects for anatomical purposes can generally be procured. In most, perhaps in all, the countries of the continent of Europe, the government has provided for the want of anatomists in this particular. In England, however, it still remains a matter of considerable difficulty and expense to procure the means of instruction in practical anatomy; and, accordingly, while foreigners have been enriching science with many splendid works, the name of one Englishman cannot for many years past be recorded in the annals of anatomy. We wish we could announce to our readers any prospect of a change in this respect; but here literature and science are left to themselves, and must advance unaided by the patronage of government, or not advance at all.

It would occupy us too long to detail the labours and discoveries of all the eminent men, who have immortalized themselves in anatomy during the last century. We may state, generally, that every part of the human body has been most thoroughly and minutely examined and described; and accurate and elegant engravings have appeared of every part. So that a student, in these days, possesses every facility for the prosecution of his anatomical labours. The bones and muscles have been most

elegantly represented and described by Albinus, Cheselden, Sue, and Cowper. The vascular system has been illustrated by a splendid work of the immortal Haller. Walker and Meckel of Berlin, and Scarpa at Pavia, have bestowed equal, or even superior, diligence in tracing the distribution of the most important nerves, and representing them in faithful engravings. Mr. Cruikshank distinguished himself by an excellent book on the absorbing system; and Mascagni has lately given to the public a most elaborate account of the absorbing vessels, with very splendid plates. Dr. Hunter, to whom anatomy owes more in this country than to any individual, has published a complete history, with beautiful explanatory engravings, of the growth of the human ovum, and of the changes which the uterus undergoes after the ovum has been received into its cavity. His brother, Mr. John Hunter, also demands mention in this place, as an accurate and minute dissector, and a patient experimentalist. He surveyed, in his researches, the whole field of animated nature, and greatly promoted the science of phisiology. He formed also the grandest and most beautiful anatomical cabinet in Europe; and this precious treasure has now passed into the hands of the Royal College of Surgeons in London. The structure of the brain has been represented with unrivalled elegance by Vicq D'Azyr, a French anatomist, in a folio volume of coloured plates, which we hesitate not to applaud as a chef d'œuvre of anatomical science, and a most splendid monument of the arts. Some parts of this most important organ have also been illustrated by the labours of Soemmering, who still prosecutes the study of anatomy with unwearied industry. We have lately, from his hands, two most finished productions, in every respect, on the anatomy of the eye and ear. It would be unjust not to enumerate, with a due tribute of applause, the labours of Zinn, Cassebohm, and Scarpa, on the same subjects.

Morgagni, who taught anatomy in Padua, published a work of great utility on morbid anatomy. Dr. Baillie has of late in this country prosecuted the same subject, though in a different manner. He has published a book on the morbid anatomy of the body, and has illustrated his descriptions by a collection of the most elegant, expressive, and accurate plates.

Winslow, Sabatier, and Bichat, are the authors of the most approved anatomical systems in France, and Soemmering and Hildebrant in Germany. We regret that it is not in our power to mention any correct and complete system by an English writer. The imperfect and contemptible ephemeral productions, published under the auspices of booksellers, cannot have a place in this enumeration.

UTILITY OF ANATOMY.

Astronomy and anatomy, as Fontenelle observes, are the studies which present us with the most striking view of the two greatest attributes of the Supreme Being. The first of these fills the mind with the idea of his immensity, in the largeness, distances, and number of the heavenly bodies; the last astonishes, with his intelligence and art in the variety and delicacy of animal mechanism.

The human body has been commonly enough known by the name of microcosmus; as if it did not differ so much from the universal system of nature, in the symmetry and number of its parts, as in their size.

Galen's excellent treatise on the use of the parts was composed as a prose hymn to the Creator, and abounds with as irresistible proofs of a Supreme Cause, and governing Providence, as we find in modern phisico-theology. And Cicero dwells more on the structure and economy of animals, than on all the productions of nature besides, when he wants to prove the existence of the Gods, from the order and beauty of the universe. He there takes a survey of the body of man, in a most elegant synopsis of anatomy, and concludes thus; "Quibus rebus expositis, satis docuisse videor, hominis natura quanto omnes anteiret animales. Ex quo debet intelligi, nec figuram situmque membrorum, nec ingenii mentisque, vim talem effici potuisse fortuna." The satisfaction of mind which arises from the study of anatomy, and the influence which it must naturally have on our minds as philosophers, cannot be better conveyed than by the following passage from the same author; "Quæ contuens animus, accepit ab his cognitionem deorum, ex qua oritur pietas: cui conjuncta justitia est, reliquæque virtutes; ex quibus vita beata exsistit, par et similis deorum, nulla alia re nisi immortalitate, quæ nihil ad bene vivendum pertinet, cedens cœlestibus."

It would be endless to quote the animated passages of this sort, which are to be found in the physicians, philosophers, and theologists, who have considered the structure and functions of animals, with a view towards the Creator. It is a view that must strike us with the most awful conviction. Who can know and consider

the thousand evident proofs of the astonishing art of the Creator, in forming and sustaining an animal body such as ours, without feeling the most pleasing enthusiasm? Can we seriously reflect upon this awful subject, without being almost lost in adoration! Without longing for another life after this, in which we may be gratified with the highest enjoyment which our faculties and nature seem capable of, the seeing and comprehending the whole plan of the Creator, in forming the universe, and directing its operations.

In the excellent work of Archdeacon Paley, on natural theology, this view of the subject is most ably explained and illustrated; and the subject is pursued through all its details. We strongly recommend this work, as exhibiting, in a popular form, a very interesting view of the structure and functions of animal bodies; and we subjoin the following extract, as a very successful application of the argument.

"It has been said, that a man cannot lift his hand to his head, without finding enough to convince him of the existence of a God. And it is well said; for he has only to reflect, familiar as this action is, and simple as it seems to be, how many things are requisite for the performing of it: how many things which we understand, to say nothing of many more, probably, which we do not; viz. first, a long, hard, strong cylinder, to give to the arm its firmness and tension; but which, being rigid, and, in its substance, inflexible, can only turn upon joints: secondly, therefore, joints for this purpose, one at the shoulder to raise the arm, another at the elbow to bend it; these joints continually fed with a soft mucilage, to make the parts slide easily upon one another, and holden together by strong braces, to keep them in their position: then, thirdly, strings and wires, *i. e.* muscles and tendons, artificially inserted, for the purpose of drawing the bones in the directions in which the joints allow them to move. Hitherto, we seem to understand the mechanism pretty well; and, understanding this, we possess enough for our conclusion: nevertheless, we have hitherto only a machine standing still; a dead organization—an apparatus. To put the system in a state of activity; to set it at work; a further provision is necessary, *viz.* a communication with the brain by means of nerves. We know the existence of this communication, because we can see the communicating threads, and can trace them to the brain; its necessity we also know, because, if the thread be cut, if the communication be intercepted, the muscle becomes paralytic: but beyond this we know little; the organization being too minute and subtle for our inspection.

"To what has been enumerated, as officiating in the single act of a man's raising his hand to his head, must be added, likewise, all that is necessary, and all that contributes to the growth, nourishment, and sustentation of the limb, the repair of its waste, the preservation of its health; such as the circulation of the blood through every part of it; its lymphatics, exhalants, absorbents; its excretions and integuments. All these share in the result; join in the effect: and how all these, or any of them, come together, without a designing, disposing intelligence, it is impossible to conceive."

But the more immediate purposes of anatomy concern those who are to be the guardians of health, as this study is necessary to lay a foundation for all the branches of medicine.

The more we know of our fabric, the more reason we have to believe, that, if our senses were more acute, and our judgment more enlarged, we should be able to trace many springs of life, which are now hidden from us; by the same sagacity we should discover the true causes and nature of diseases, and thereby be enabled to restore the health of many, who are now, from our more confined knowledge, said to labour under incurable disorders. By such an intimate acquaintance with the economy of our bodies, we should discover even the seeds of diseases, and detroy them, before they had taken root in the constitution.

This, indeed, is a pitch of knowledge which we must not expect to attain. But, surely, we may go some way; and, therefore, let us endeavour to go as far as we can. And if we consider that health and disease are the opposites of each other, there can be no doubt, that the study of the natural state of the body, which constitutes the one, must be the direct road to the knowledge of the other. What has been said, of the usefulness of anatomy in physic, will only be called in question by the more illiterate empirics among physicians. They would discourage others from the pursuit of knowledge which they have not themselves, and which, therefore, they cannot know the value of, and tell us that a little of anatomy is enough for a physician.

That anatomy is the very basis of surgery every body allows. It is dissection alone that can teach us where we may cut the living body with freedom and dispatch; where we may venture with great

circumspection and delicacy; and where we must not, upon any account, attempt it. This informs the head, gives dexterity to the hand, and familiarizes the heart with a sort of necessary inhumanity, the use of cutting instruments upon our fellow-creatures.

Were it possible to doubt of the advantages which arise in surgery, from a knowledge of anatomy, we might have ample conviction, by comparing the present practice with that of the ancients: and upon tracing the improvements which have been made in later times, they would be found, generally, to have sprung from a more accurate knowledge of the parts concerned. In the hands of a good anatomist, surgery is a salutary, a divine art; but when practised by men who know not the structure of the human body, it often becomes barbarous and criminal.

The comparison of a physician to a general is both rational and instructive. The human body, under a disease, is the country which labours under a civil war or an invasion. The physician is, or should be, the dictator or general, who is to take the command, and to direct all the necessary operations. To do his duty with full advantage, a general, besides other acquirements, useful in his profession, must make himself master of the anatomy and physiology, as we may call it, of the country. He may be said to be master of the anatomy of the country, when he knows the figure, dimension, situation, and connection, of all the principal constituent parts; such as the lakes, rivers, marshes, mountains, precipices, plains, woods, roads, passes, fords, towns, fortifications, &c. By the physiology of the country, which he ought likewise to understand, is meant all the variety of active influence which is produced by the inhabitants. If the general be well instructed in all these points, he will find a hundred occasions of drawing advantages from them; and without such knowledge, he will be for ever exposed to some fatal blunder.

GENERAL ACCOUNT OF THE COMPOSITION OF THE BODY.

After having considered the rise and progress of anatomy; the various discoveries that have been made in it from time to time; the great number of diligent observers who have applied themselves to this art; and the importance of the study, not only for the prevention and cure of diseases, but in furnishing the liveliest proofs of divine wisdom; the following questions seem naturally to arise. For what purpose is there such a variety of parts in the human body? Why such a complication of nice and tender machinery? Why was there not rather a more simple, less delicate, and less expensive frame?

That beginners in the study of anatomy may acquire a satisfactory, general, idea of these subjects, we shall furnish them with clear answers to all such questions. Let us then, in our imagination, make a man: in other words, let us suppose that the mind, or immaterial part, is to be placed in a corporeal fabric, to hold a correspondence with other material beings, by the intervention of the body; and then consider, *a priori*, what will be wanted for her accommodation. In this inquiry we shall plainly see the necessity, or advantage, and therefore the final cause, of most of the parts, which we actually find in the human body. And if we consider, that, in order to answer some of the requisites, human art and invention would be very insufficient, we need not be surprised if we meet with some parts of the body, the use of which we cannot yet make out; and with some operations or functions which we cannot explain. We can see and comprehend that the whole bears the strongest marks of excelling wisdom and ingenuity; but the imperfect senses and capacity of man cannot pretend to reach every part of a machine, which nothing less than the intelligence and power of the Supreme Being could contrive and execute.

To proceed then; in the first place, the mind, the thinking immaterial agent, must be provided with a place of immediate residence, which shall have all the requisites for the union of spirit and body; accordingly, she is provided with the brain, where she dwells as governor and superintendant of the whole fabric.

In the second place, as she is to hold a correspondence with all the material beings which surround her, she must be supplied with organs fitted to receive the different kinds of impressions that they will make. In fact, therefore, we see that she is provided with the organs of sense, as we call them; the eye is adapted to light, the ear to sound, the nose to smell, the mouth to taste, and the skin to touch.

In the third place, she must be provided with organs of communication between herself, in the brain, and those organs of sense, to give her information of all the impressions that are made upon them: and she must have organs between herself, in the brain, and every other part of the body, fitted to convey her commands and influence over the whole. For these purposes the nerves are actually given.

They are chords, which rise from the brain, the immediate residence of the mind, and disperse themselves in branches through all parts of the body. They are intended to be occasional monitors against all such impressions as might endanger the well-being of the whole, or of any particular part, which vindicates the Creator of all things in having actually subjected us to those many disagreeable and painful sensations, which we are exposed to from a thousand accidents in life.

Further, the mind, in this corporeal system, must be endued with the power of moving from place to place, that she may have intercourse with a variety of objects; that she may fly from such as are disagreeable, dangerous, or hurtful, and pursue such as are pleasant or useful to her. And accordingly she is furnished with limbs, and with muscles and tendons, the instruments of motion, which are found in every part of the fabric where motion is necessary.

But to support, to give firmness and shape to the fabric, to keep the softer parts in their proper places, to give fixed points and the proper direction to its motions, as well as to protect some of the more important and tender organs from external injuries, there must be some firm prop-work interwoven through the whole. And, in fact, for such purposes the bones are given.

The prop-work must not be made into one rigid fabric, for that would prevent motion. Therefore there are a number of bones. These pieces must all be firmly bound together, to prevent their dislocation, and this end is perfectly well answered by the ligaments. The extremities of these bony pieces, where they move and rub upon one another, must have smooth and slippery surfaces, for easy motion. This is most happily provided for by the cartilages and mucus of the joints.

The interstices of all these parts must be filled up with some soft and ductile matter, which shall keep them in their places, unite them, and at the same time allow them to move a little upon one another. This end is accordingly answered by the cellular membrane, or adipous substance.

There must be an outward covering over the whole apparatus, both to give it a firm compactness, and to defend it from a thousand injuries, which, in fact, are the very purposes of the skin, and other integuments.

As she is made for society and intercourse with beings of her own kind, she must be endued with powers of expressing and communicating her thoughts by some sensible marks or signs, which shall be both easy to herself, and admit of great variety. Hence she is provided with the organs and faculty of speech, by which she can throw out signs with amazing facility, and vary them without end.

Thus we have built up an animal body, which would seem to be pretty complete; but we have not yet made any provision for its duration: and, as it is the nature of matter to be altered and worked upon by matter, so in a very little time such a living creature must be destroyed, if there is no provision for repairing the injuries which she must commit upon herself, and the injuries which she must be exposed to from without. Therefore a treasure of blood is actually provided in the heart and vascular system, full of nutritious and healing particles, fluid enough to penetrate into the minutest parts of the animal. Impelled by the heart, and conveyed by the arteries, it washes every part, builds up what was broken down, and sweeps away the old and useless materials.

Hence we see the necessity or advantage of the heart and arterial system: the overplus of this blood, beyond what was required to repair the present damages of the machine, must not be lost, but should be returned again to the heart; and for this purpose the venal system is actually provided. These requisites in the animal explain, *a priori*, the circulation of the blood.

The old materials, which are become useless, and are swept off by the current of blood, must be separated and thrown out of the system. Therefore glands, the organs of secretion, are given, for straining whatever is redundant, vapid, or noxious, from the mass of blood: and, when strained, it is thrown out by excretories.

Now, as the fabric must be constantly wearing, the reparation must be carried on without intermission, and the strainers must always be employed: therefore there is actually a perpetual circulation of the blood, and the secretions are always going on.

But even all this provision would not be sufficient; for that store of blood would soon be consumed, and the fabric would break down, if there were not a provision made for fresh supplies. These we observe, in fact, are profusely scattered round her in the animal and vegetable kingdoms; and she is provided with hands, the finest instruments that could have been contrived for gathering them, and for preparing them in a variety of different ways for the mouth. These supplies,

which we call food, must be considerably changed; they must be converted into blood: therefore she is provided with teeth for cutting and bruising the food, and with a stomach for melting it down; in short, with all the organs subservient to digestion. The finer parts of the aliments only can be useful in the constitution: these must be taken up, and conveyed into the blood, and the dregs must be thrown off. With this view the intestinal canal is constructed. It separates the nutritious part, which we call chyle, to be conveyed into the blood by the system of absorbent vessels; and the feces pass downwards, to be conducted out of the body.

Now we have got our animal, not only furnished with what is wanted for its immediate existence, but also with the power of spinning out that existence to an indefinite length of time. But its duration, we may presume, must necessarily be limited: for as it is nourished, grows, and is raised up to its full strength and perfection, so it must, in time, in common with all material things, begin to decay, and then hurry on to final ruin. Hence we see the necessity of a scheme for renovation. Accordingly, a wise Providence, to perpetuate as well as to preserve his work, besides giving a strong appetite for life and self-preservation, has made animals male and female, and given them such organs and passions as will secure the propagation of the species to the end of the world.

Thus we see, that by the very imperfect survey which human reason is able to take of this subject, the animal man must necessarily be complex in his corporeal system, and in its operations. He must have one great and general system, the vascular, branching through the whole for circulation: another, the nervous, with its appendages, the organs of sense, for every kind of feeling: and a third, for the union and connection of all those parts.

Besides these primary and general systems, he requires others, which may be more local or confined: one for strength, support, and protection; the bony compages: another for the requisite motions of the parts among themselves, as well as for moving from place to place; the muscular part of the body: another to prepare nourishment for the daily recruit of the body; the digestive organs: and one for propagating the species; the organs of generation.

In taking this general survey of what would appear, *a priori*, to be necessary for adapting an animal to the situations of humanity, we observe, with great satisfaction, that man is in fact made of such systems, and for such purposes. He has them all, and he has nothing more, except the organs of respiration. Breathing we cannot account for *a priori*, we only know that it is in fact essential to life. Notwithstanding this, when we see all the other parts of the body, and their functions, so well accounted for, and so wisely adapted to their several purposes, we cannot doubt that respiration is so likewise. We find, in fact, that the blood in its circulation becomes altered in its properties, and that these are renewed by the absorption of the oxygenous or pure part of the atmosphere in the lungs; we find also, that this function is the means of supporting the temperature of the animal.

The use and necessity of all the different systems in a man's body is not more apparent, than the wisdom and contrivance which has been exerted in putting them all into the most compact and convenient form, and in disposing them so, that they shall mutually receive and give helps to one another, and that all, or many of the parts, shall not only answer their principal end or purpose, but operate successfully and usefully in many secondary ways.

If we understand and consider the whole animal machine in this light, and compare it with any machine, in which human art has done its utmost, suppose the best constructed ship that ever was built, we shall be convinced, beyond the possibility of doubt, that there is intelligence and power far surpassing what humanity can boast of.

In making such a comparison, there is a peculiarity and superiority in the natural machine, which cannot escape observation. It is this; in machines of human contrivance or art, there is no internal power, no principle in the machine itself, by which it can alter or accommodate itself to any injury which it may suffer, or make up any injury which is reparable. But in the natural machine, the animal body, this is most wonderfully provided for by internal powers in the machine itself, many of which are not more certain or obvious in their effects, than they are above all human comprehension as to the manner and means of their operation. Thus, a wound heals up of itself; a broken bone is made firm again by callus; a dead part is separated and thrown off; noxious juices are driven out by some of the emunctories; a redundancy is removed by some spontaneous bleeding; a

bleeding naturally stops of itself; and a great loss of blood, from any cause, is in some measure compensated by a contracting power in the vascular system, which accommodates the capacity of the vessels to the quantity contained. The stomach gives information when the supplies have been expended, represents with great exactness the quantity and quality of what is wanted in the present state of the machine, and in proportion as she meets with neglect, rises in her demand, urges her petition in a louder voice, and with more forcible arguments. For its protection, an animal body resists heat and cold in a very wonderful manner, and preserves an equal temperature in a burning and in a freezing atmosphere.

There is a farther excellence or superiority in the natural machine, if possible, still more astonishing, more beyond all human comprehension, than what we have been speaking of. Besides those internal powers of self-preservation in each individual, when two of them cooperate, or act in concert, they are endued with powers of making other animals or machines like themselves, which again are possessed of the same powers of producing others, and so of multiplying the species without end. These are powers which mock all human invention or imitation, they are characteristics of the Divine Architect.

As the body is a compound of solids and fluids, anatomy is divided into,

1. The anatomy of the solids, and
2. The anatomy of the fluids.

The solids of the human body consist of,

1. Bones, which give support to the other parts of the body;
2. Cartilages, or gristles, which are much softer than the bones, and also flexible and elastic;
3. Ligaments, which are more flexible still, and connect the ends of the bones to each other;
4. Membranes, or planes of minutely interwoven and condensed cellular substance;
5. Cellular substance, which is formed of fibres and plates of animal matter more loosely connected, and which forms the general uniting medium of all the structures of the body;
6. Fat, or adipous substance, an animal oil contained in the cells of the cellular membrane;
7. Muscles, which are bundles of fibres, endued with a power of contraction; in popular language they form the flesh of an animal;
8. Tendons, hard inelastic cords, which connect the muscles or moving powers to the bones or instruments of motion;
9. Viscera, which are various parts, adapted for different purposes in the animal economy, and contained in the cavities of the body, as the head, chest, abdomen, and pelvis;
10. Glands, organs which secrete or separate various fluids from the blood;
11. Vessels, which are membranous canals, dividing into branches, and transmitting blood and other fluids;
12. Cerebral substance, or that which composes the brain and spinal marrow, which is a peculiar soft kind of animal matter:
13. Nerves, which are bundles of white fibrous cords, connected by one end to the brain, or spinal marrow, and thence expanded over every part of the body, in order to receive impressions from external objects, or to convey the commands of the will, and thereby produce muscular motion.

The fluids of the human body are,

1. Blood, which circulates through the vessels, and nourishes the whole fabric;
2. Persipirable matter, excreted by the vessels of the skin;
3. Sebaceous matter, by the glands of the skin;
4. Urine, by the kidneys;
5 Ceruminous matter, secreted by the glands of the external ear;
6. Tears, by the lachrymal glands;
7. Saliva, by the salivary glands;
8. Mucus, by glands in various parts of the body, and by various membranes;
9. Serous fluid, by membranes lining circumscribed cavities;
10. Pancreatic juice, by the pancreas;
11. Bile, by the liver;
12. Gastric juice, by the stomach;
13. Oil, by the vessels of the adipose membrane;
14. Synovia, by the internal surfaces of the joints, for the purpose of lubricating them;
15. Seminal fluids, by the testes;
16. Milk, by the mammary glands.

The account of these animal fluids will be found chiefly under the article PHYSIOLOGY.

The anatomical deecription of the body is technically arranged under the following heads:

1. Osteology, or the description of the structure, shape, and uses of the bones.
2. Syndesmology, or a description of the connection of bones by ligaments, and of the structure of the joints.

3. Myology, or doctrine of the moving powers or muscles.

4. Angeiology, or description of the vessels engaged in nourishing the body, in absorption, and in the removal of superfluous parts.

5. Adenology, or account of the glands, in which various liquors are separated or prepared from the blood.

6. Splanchnology, or a description of the different bowels which serve various and dissimilar purposes in the animal economy.

7. Neurology, under which title the brain, the nerves, and the organs of sense must be comprehended.

The functions carried on in animals, in the explanation of which physiology consists, and for the detailed account of which we refer the reader to the article Physiology, may be thus arranged.

1. Digestion, or the conversion of extraneous matter into a substance fit for the nourishment of their own bodies.

2. Absorption, by which the nutritive fluid is taken up and conveyed into the vascular system, and by which the old parts of our body are removed.

3. Respiration, or the exposure of the nutritive fluid to the action of the atmosphere.

4. Circulation, or the distribution of the converted matter to every part of the animal, for its repair and augmentation. The process is named circulation, from the mode in which it is carried on in the generality of animals.

5. Secretion, or the separation and deposition of the particles composing the structure of animals and vegetables, as well as the formation of various substances which they produce from the circulating fluids.

6. Irritability, or the principle by which living fibres contract, by means of which absorption and circulation are carried on, and which is more strikingly manifested by the occasional exertions of the muscular powers.

7. Sensation, by which animals become conscious of their own existence, and of that of external bodies.

8. Generation, by which new beings, similar to the parents, are formed and produced.

PARTICULAR ANATOMICAL DESCRIPTION OF THE HUMAN BODY.

After a cursory notice of the cellular substance, which forms the grand uniting medium of the various structures in the body, and of membranes, which are formed of that substance, we shall proceed to describe the other parts, chiefly according to the technical arrangement above mentioned.

Cellular substance, or cellular membrane, tela cellulosa or mucosa of Latin writers, is the medium which connects and supports all the various parts and structures of the body. Any person may gain a general notion of this substance, by observing it in joints of veal, where it is always inflated by the butchers. It consists of an assemblage of fibres and laminæ of animal matter, connected to each other so as to form innumerable cells or small cavities, from which its name of *cellular* is derived. It pervades every part of the animal structure. By joining together the minute fibrils of muscle, tendon, or nerve, it forms obvious and visible fibres; it collects these fibres into large fasciculi; and by joining such fasciculi or bundles to each other, constitutes an entire muscle, tendon, or nerve. It joins together the individual muscles, and is collected in their intervals. It surrounds each vessel and nerve in the body; often connecting these parts together by a firm kind of capsule, and in a looser form joining them to the neighbouring muscles, &c. When condensed into a firm and compact structure, it constitutes the various membranes of the body, which, by long maceration in water, may be resolved into a loose cellular texture. In the bones it forms the basis or ground-work of their fabric, a receptacle, in the interstices of which the earth of bone is deposited. As cellular substance is entirely soluble in boiling water, it is ascribed by chemists to that peculiar modification of animal matter termed *gelatine*. In consequence of its solution by the united agencies of heat and moisture, the muscular fibres separate from each other, and form the other structures of the body. This effect is seen in meat which is subjected to long boiling or stewing for the table, or indeed in a joint which is merely over-boiled.

Its watery solution assumes, when cold, the appearance of jelly; and, after a particular mode of preparation, constitutes glue.

The interstices of the cellular substance are lubricated and moistened by a serous or watery fluid, poured out by the exhalant arteries, and again taken in by the lymphatics. It thus acquires a pliancy and softness, which adapt it particularly to serve as a connecting medium for parts which have motion on each other. The importance of this property will be best understood by observing the effects of

its loss. Inflammation or abscess often causes an induration or consolidation of the cellular texture, by which the integuments are fixed to the muscles, the muscles are firmly united to each other, and to the surrounding parts, and the motions of the whole are considerably impaired.

From the universal extent of this cellular texture, two conclusions may be drawn; 1st, it forms the basis of the whole animal fabric, in such a way, that if we conceive every part removed but this, the form of the whole would still be expressed in cellular substance; 2dly, it forms a connection and passage between all parts of the body, however remote in situation, or dissimilar in structure. For the cells of this substance every where communicate; as we may collect from facts of the most common and familiar occurrence. In emphysema, where air escapes from the lung wounded by a broken rib into the cellular substance, it spreads rapidly from the chest into the most remote parts of the body; and has even been known to gain admission into the eye-ball. A similar diffusion of this fluid may be effected by artificial inflation, which is commonly practised by butchers on the carcases of calves. In anasarca, or preternatural accumulation of fluid in the cellular substance, the most depending parts are the most loaded; and punctures in these drain the water off from the whole body.

Adipous substance, or fat.—The cells of the cellular substance, in many parts of the body, are destined for the reception of a fluid, termed fat. This is of an unctuous nature, inflammable, lighter than water, usually inodorous, and, generally speaking, similar to the vegetable oils. It is white in young animals, and becomes yellower as they advance in age: this difference may be seen in the carcases of a calf and cow. It is always more or less fluid in the living subject; in carnivorous animals, and in man, it retains much of its oily appearance after death; but in herbivorous animals it constantly assumes a concrete form. Dr. Hunter called those parts of the cellular substance which contain fat, *adipous cellular substance;* and distinguished the other by the epithet *recticular.*

As the fat is deposited in cells, it assumes in general a kind of granular form. It varies considerably in consistence. That of the orbit is the softest in the body, and forms a well-known epicurean *bonne bouche,* in a boiled calf's head. The fat about the kidneys becomes particularly hard after death, and is called suet. The globules or portions of this are very large, and it contains on the whole less cellular substance than any fat in the body. There is generally a layer of fat under the skin; whence a membrana adiposa has been sometimes enumerated as one of the common integuments of the body.

Some parts of the body never contain fat, even in subjects who have the greatest accumulation of this fluid. This is the case with the scrotum, the integuments of the penis, and the eye-lids: it is obvious that the functions of these parts would be completely destroyed, if they were subject to the enormous accumulations of fat, which occur in other parts of the body. Several of the viscera also never contain any fat, probably for the same reason; this is the case with the brain and lungs.

The quantity of fat varies according to the age, the state of health, and the peculiar habit or disposition of the individual. It is not found in the early periods of fœtal existence; and cannot be distinguished with any certainty sooner than the fifth month after conception.

In the fœtus, and for some time after birth, the fat is confined to the surface of the body, and is only found in a stratum under the skin. It begins, however, gradually to be deposited in the intervals of the muscles, and on the surface of some viscera. In old subjects, however thin they may seem on an external view, there is always much fat, penetrating even the substance of the muscles: the bones are greasy throughout; the heart is more or less loaded, as are also the parts in the abdomen.

There is a considerable difference in the quantity of fat in different individuals: and in some there is a propensity or disposition to its accumulation; a sedentary life, copious food, and tranquil state of the mind, are particularly favourable to the increase of fat, which sometimes proceeds to such a pitch, from the continuance of these causes, that it must be considered as a disease, and is attended with the greatest inconvenience to the individual. General diseases of the frame are commonly attended with an absorption of the fat from the cellular substance: acute disorders cause a very rapid emaciation. In no case is the adipous substance more completely removed from the whole body than in anasarca, where its place is supplied by a serous fluid.

The uses of the fat seem to be, in part, common to it with the cellular substance: it connects contiguous parts, and at the same time prevents their coalition. It ad-

mits of their moving on each other with freedom and facility. Its deposition under the integuments gives a roundness and convexity to the surface, on which the beauty of the human form principally depends. Indeed, its accumulation in particular situations immediately influences the outline of the part; as in the orbit, the cheek, and the buttocks. The effects of its loss is most disagreeably manifested in the lank cheek and hollow eye of an emaciated patient.

It has been supposed that the fat absorbed under certain circumstances is applied to the nutrition of the body; as in hybernating animals.

Membranes.—In the foregoing observations on cellular substance, we have stated that membranes are formed by a condensation of that substance. They consist of thin sheets of compacted and close cellular texture. This is proved by long maceration in water. The fluid gradually penetrates the interstices, and resolves the membrane into a loose and flocculent substance. They are found in every variety of density and softness.

A grand use of membranes is, to line what anatomists call the *circumscribed cavities* of the body. These are hollow spaces, containing the different viscera, and in every instance completely and accurately filled by such viscera; so that the term cavity, when used by anatomists, does not, as in common language, denote a void or empty space.

Membranes have a smooth internal polished surface, turned towards the contained viscera. This is constantly moistened by a lubricating fluid exhaled by the minute arteries of the part, and bestows on the surface of the membrane the greatest softness and smoothness. Hence the motions of the viscera are performed with perfect facility, and they are prevented from adhering to each other, or to the sides of the containing cavity. The extent of such cavities is bounded and defined by the lining membranes, and hence arises the epithet *circumscribed.* To increase the facility of motion, the surface of the contained viscera is covered by a continuation of the same membrane, and always therefore possesses the same smoothness and polish with the sides of the cavity. The membrane lining a circumscribed cavity is a complete and entire sac, which is reflected over all the viscera contained in the cavity. In the carcase of an animal just slaughtered, the lubricating secretion flies off in the form of a fine vapour when the cavity of the belly or chest is laid open. It is nothing more than an increase of this natural secretion, combined perhaps with a deficient absorption, that gives rise to dropsies of the different cavities.

The opposite or external surface of the membrane is rough and cellular; and adheres to the various parts which form the sides of the cavity.

Another use of membranes is, to form blood-vessels or tubes for conveying the nutritious fluid to all parts of the body. The bore or hollow of the tube is perfectly smooth and polished, so that the blood experiences no obstruction in its course; and the external surface is rough, to connect it with the surrounding parts. In a similar manner are formed the stomach and intestines, which receive the food; the urinary bladder, which holds the urine, &c.

It must be obvious, that for all the purposes which we have enumerated, whether for lining circumscribed cavities, for conveying the blood, for receiving the food, or holding any other liquors, it is essentially necessary that membranes should be impermeable to fluids in the living state.

OSTEOLOGY.

The bones are the most solid parts of the body. They are composed of a vascular substance, not differing materially in structure from that of the rest of the body, except that there is deposited in its interstices an earthy matter, which gives to the whole mass rigidity, strength, and a permanent figure. The nutrient vessels of arteries, membranes, and ligaments, occasionally deposit lime, and cause the ossification of those parts.

The account of the original formation of the bones in the fœtus, is technically termed *osteogeny.* The parts of the young fœtus, which are afterwards to become bones, are at first cartilaginous; and their substance is rendered white and firm, in proportion to the quantity of lime deposited in it. The quantity at the time of birth is only sufficient to give firmness to the whole mass, not to prevent its flexibility.

The extremities of all the long bones consist of large portions of cartilage, and these by degrees become bony. The formation of bone begins in the centre of the cartilage, and gradually extends from thence to the remote parts, so that the separate piece of bone, formed at the extremity, remains till near the time of puberty, conjoined to the body of the bone

by a crust of cartilage. In this state it is technically termed an *epiphysis*. The body, or middle part of the bone, is called the *diaphysis*. The projecting parts, or processes of bones, are also in many instances originally *epiphyses*. The time by which these epiphyses are consolidated by a bony union with the diaphysis, varies in different bones, but it is not prolonged in any much beyond the age of puberty.

We perceive an evident advantage in the bones of the fœtus being formed as they are. Their flexibility admits of the form of the limbs becoming adapted to the varying figure of the pelvis, through which they must pass; and their elasticity, which is powerful, restores them afterwards to their natural shape.

The animal substance contained in bones is demonstrated by immersion in weak acids, which dissolve the earth, and leave a kind of cartilage similar to that in which the bone was originally formed. Long boiling in a close vessel removes the gelatinous substance, which is dissolved in the water. The earth of bones is demonstrated by calcination, which drives off the animal matter, and leaves the earth alone behind. This earth consists chiefly of phosphate of lime; but there is also a small proportion of carbonate of lime. In young subjects the animal substance predominates, and the bone appears redder, in consequence of the arteries being larger and more numerous. The bones of old persons contain more earth, and are consequently whiter and less vascular.

Some recent experiments have shewn the quantity of jelly contained in bones to be much larger than was supposed, and as it forms a very good soup when dissolved in water, the circumstance is of considerable importance, as furnishing an article capable of supplying much wholesome nutriment. The quantity of soup furnished from a given bulk of bruised or pounded bones, boiled in a vessel with a closed lid, considerably exceeds that which can be extracted from the same quantity of meat. Of course the articular heads of bones, and the reticular texture, in general furnish the greatest quantity.

It has been generally taught, that bones are composed of fibres and laminæ: the fact is, that they consist of a reticulated texture, very similar to cellular substance in other parts of the body.

According to the obvious differences in their forms, bones are divided into the long and flat.

Two kinds of structure may be observed in all bones: in the one, the bony substance is condensed, and leaves no interstices; in the other, there is a mere net-work of bony fibres and plates, leaving numerous intervals. The latter is termed the cancellous substance of bones.

The cylinder of a long bone is composed entirely of the firmer substance, and in its centre is hollowed out to contain the marrow. In those extremities of the bones, which form the joints, which are greatly expanded, in order to increase the extent of surface, there is a thin layer of the compact substance, but all the interior is cancellous. In broad or flat bones, the firmer substance is formed into two plates or tables, and the interval between these is occupied by cancelli.

Many advantages arise from this arrangement of the earth of bones. The long bones are made slender in the middle, to allow of the convenient collocation of the large muscles around them; they become expanded at their extremities, to afford an extent of surface for the formation of joints, and the support of the weight of the body. A cavity is left in the middle; for if all the earthy matter had been compacted into the smallest possible space, the bones would have been such slender stems, as to be very unsuitable to their offices; and if they had been of their present dimensions, and solid throughout, they would have been unnecessarily strong and weighty.

The phenomena, which result from feeding an animal with madder, sufficiently demonstrate the existence of blood-vessels and absorbents in the bones. There is a strong attraction between the earth of bone and the colouring matter; by means of which they unite and form a beautiful red substance. The whole of the bones of an animal assume this colour soon after an animal has been taking the madder. If it be left off, the bones in a short time resume their natural white appearance, from the absorption of the red colouring substance. The short time in which growing bones become thoroughly dyed, and in which again the preternatural tint is lost, prove that even in these, the hardest parts of our frames, there is a process of removal of old parts, and deposition of new ones constantly going on.

That bones possess nerves, as well as arteries, veins, and absorbents, cannot be doubted. Although in the natural state they seem to be insensible, they become extremely painful when diseased; and again, a fungus, which is sensible, some-

times grows out of a bone, though it may have no connexion whatever with the surrounding soft parts; of course it must have derived its nerves, by means of which it possesses sensation, from the bone out of which it arose.

Bones are covered by a strong and firm membrane, termed *periosteum*, on which the vessels are first distributed; from this they descend into the substance of the bone. The vessels enter through holes which are evident on the surface, and which are larger and more numerous in the extremities of the long bones than in the middle.

OF THE MARROW.

This is of an oily nature. It hardens when cold, in herbaceous animals; but it remains fluid in those which are carnivorous. It has a reddish and bloody appearance in young animals; but this soon goes off. It is contained in fine membranous cells, which do not communicate with each other. The marrow occupies the tube left in the middle of the long bones, and also fills the cancelli of their extremities.

The cellular substance, which contains the marrow, being condensed upon the inside of the walls of the bone, and adhering to them, has been termed the *periosteum internum.*

We observe in the principal bones arteries, much larger than those which nourish the bone, penetrating these bodies obliquely, and spreading their branches upon the medullary cells.

Various unsatisfactory opinions have been proposed concerning the use of the marrow. The utility of the bones being formed as they are, small and tubular in the middle, expanded and spongy at their extremities, has been already explained. If then spaces are necessarily left in their interior parts, those spaces must be filled with something; for they cannot be left void, or the immense pressure of the atmosphere would crush their sides, and destroy the vacuum. There is no matter in the animal body more suitable to fill their spaces than the marrow; and it is to be regarded as a part of the adipous system of the animal.

From the circumstances which have been detailed in the foregoing account, *viz.* the great and general vascularity of bones; the quantity of soft substance existing in every part of them; their growth and mutation of form in disease, &c. it is natural to conclude, that there exist in the composition of every bony fibre, arteries for its formation, absorbents for its removal, cellular substance for the connexion of its parts, and nerves to give animation to the whole. In this view of the subject, we see no essential difference of structure between bones and other parts of the body; nor do we expect any essential difference in the functions of their nutrient and other vessels. We naturally conclude that bony fibres are formed and repaired, and that they undergo mutation and removal in the same manner, and from the same causes, that soft parts do.

CARTILAGE.

Is a semipellucid substance, of a milk-white or pearly colour, entering into the composition of several parts of the body. It holds a middle rank, in point of firmness, between bones, or hard parts, and the softer constituents of the human frame. It appears, on a superficial examination, to be homogeneous in its texture; for, when cut, the surface is uniform, and contains no visible cells, cavities, nor pores; but resembles the section of a piece of glue. It possesses a very high degree of elasticity; which property distinguishes it from all other parts of the body. Hence it enters into the composition of parts, whose functions require the combination of firmness with pliancy and flexibility: the preservation of a certain external form, with the power of yielding to external force or pressure.

Cartilages are covered by a membrane, resembling, in texture and appearance, as well as in its office, the periosteum of bones; this is termed the perichondrium. They receive arteries and veins from this membrane: these vessels, however, have never been demonstrated in the cartilaginous crusts of articular surfaces. Absorbent vessels cannot be actually shewn, but their existence is abundantly proved by many phenomena. The conversion of cartilage into bone is alone sufficient for this purpose. The cartilaginous substance is gradually removed, as the formation of the bone advances. In affections of the joints, their cartilaginous coverings are often both entirely destroyed, or partially removed: which appearances can only be ascribed to the action of absorbent vessels

It does not seem to possess nerves, as it is entirely destitute of sensibility.

The thinner cartilages of the body are resolved by maceration into a kind of fibrous substance: *e. g.* those of the or-

gans of sense. Those of the ribs are found by long maceration to consist of concentric oval laminæ. In some there are tendinous fibres intermixed; as in those of the vertebræ.

Anatomists divide cartilages into two kinds: the temporary and the permanent. The former are confined to the earlier stages of existence: the latter commonly retain their cartilaginous structure throughout every period of life.

The temporary cartilages are those in which the bones of the body are formed. They are hence called by the Latin writers *ossescentes.* All the bones of the body, except the teeth, are formed in a nidus of cartilage. The form of the bone, with its various processes, is accurately represented in these cartilaginous primordia; and it is the substance alone which changes.

The permanent cartilages are of various kinds. We find them composing the external ear, external aperture of the nostrils, and eye-lids. The larynx is entirely composed of this substance; and the trachea, with its branches, is furnished with cartilaginous hoops, by which these tubes are kept permanently open, for the ready passage of air to and from the lungs.

The bodies of the vertebræ are joined by large masses of a peculiar substance; partaking of the properties and appearance of cartilage and ligament, which allow of the motions of these parts on each other, without weakening the support that is afforded to the upper parts of the body in general, and to the head in particular, by the vertebral column. These cartilages impart a great elasticity to the spine; by which the effects of concussion from jumping, from falls, &c. are weakened, and destroyed, before they can be propagated to the head. When the body has been long in an erect position, the compression of these cartilages, by the superior parts, diminishes the height of the person. They recover their former length, when freed from this pressure: hence a person is taller when he rises in the morning, than after sustaining the fatigues of the day, and the difference has sometimes amounted to an inch.

Cartilages are sometimes interposed between the articular surfaces of bones, where they fill up irregularities, that might otherwise impede the motions of the part; and increase the security of the joint, by adapting the articular surfaces to each other.

The articular surfaces of bones are, in every instance, covered by a thin crust of cartilage, having its surface most exquisitely polished, by which all friction in the motions of the joint is avoided, and the ends of the bones glide over each other with the most perfect facility.

Nomenclature of bones.—The processes or apophyses of bones bear different names, according to their figures. Hence we find them described under the terms of head (roundish ball); condyle (a flattened head); neck; tuberosity; spine; &c. others have particular names from supposed resemblances.

The cavities or depressions of bones are called cotyloid, when deep; glenoid, when shallow. Again, we have pits, furrows, notches, sinuosities, fossæ, sinuses, foramina, and canals.

Connection of bones.—Anatomists have divided these into three classes; Symphysis, Synarthrosis, and Diarthrosis.

The term symphysis merely denotes the union of the conjoined bones, without any reference to peculiar form or motion; hence it is divided, according to the means by which it is effected, into

1. Synchondrosis, where cartilage is the connecting medium: this is exemplified in the junction of the ribs and sternum; of the bodies of the vertebræ; and of the ossa pubis:

2. Synneurosis or syndesmosis; where ligaments are the connecting bodies, as in all the moveable articulations:

3. Syssarcosis; where muscles are stretched from one bone to another.

The synarthrosis, or immovable conjunction of bones, consists of,

1. Suture; where the bones are mutually indented, as if sewn together:

2. Harmonia; where the conjunction is effected by plane surfaces:

3. Gomphosis; where one bone is fixed in another, as a nail is in a board. The teeth afford the only specimen:

4. Schindylesis; where the edge of one bone is received into a groove in another: as the nasal plate of the ethmoid, in the vomer.

Diarthrosis, or moveable conjunction of bones. The conjoined parts of the bones are covered with a smooth cartilage, and connected by one or more ligaments. It has three subdivisions; *viz.*

1. Enarthrosis, or ball and socket; where a round head of one bone is received into a cavity of another, and consequently is capable of motions in all directions;

2. Arthrodia; where the cavity is more superficial, and much motion not allowed;

3. Ginglymus; where the motions are

restricted to two directions, as in the hinge of a door.

The skeleton consists of an assemblage of all the bones in the body, excepting the os hyoides. It is said to be a natural skeleton when the bones are connected by means of their own ligaments or cartilages; an artificial one, when wire or other extraneous substances are employed.

It is divided into the head, trunk, and extremities.

The head consists of the cranium and the face. The former of these parts consists of 1 or 2 ossa frontis; 2 ossa parietalia; 1 os sphenobasilare; 2 ossa temporum; 2 mallei ; 2 incudes; 2 orbicularia; 2 stapedes; and 1 os æthmoideum: on the whole, of 15 or 16 bones.

The face has 2 ossa maxillaria superiora; 2 ossa palati; 2 ossa malæ; 2 ossa nasi; 2 ossa lacrymalia or uncuis; 2 ossa turbinata inferiora; 1 os vomer; 1 maxilla inferior; 32 teeth; on the whole, 46 bones.

The os hyoides consists of a body, 2 lateral portions called cornua, and 2 sural processes called appendices.

The bones of the head are therefore 61 or 62; with the os hyoides 66 or 67.

In the neck there are 7 cervical vertebræ; in the chest 12 dorsal vertebræ; 24 ribs; 2 or 3 bones of the sternum; in the loins 5 lumbar vertebræ; in the pelvis 1 sacrum, 4 ossa coccygis, 2 ossa innominata.

Therefore the whole trunk has 57 or 58 bones.

The shoulders have two clavicles, and 2 scapulæ; the arms 2 humeri; the fore-arms 2 ulnæ and 2 radii; the wrists 2 ossa scaphoidea; 2 ossa lunaria; 2 ossa cuneiformia; 2 ossa pisiformia; 2 ossa trapezia; 2 ossa trapezioidea; 2 ossa magna; 2 ossa unciformia; the metacarpi 10 metacarpal bones; the fingers 10 posterior phalanges, 8 middle phalanges, 10 anterior phalanges, and 8 sesamoid bones.

The bones of the upper extremities are in the whole 72.

The thighs have 2 femora; the legs 2 tibiæ, 2 patellæ, and 2 fibulæ; the tarsi 2 astragali, 2 ossa calcis, 2 ossa navicularia, 6 cuneiform bones, 2 ossa cuboidea; the metatarsi 10 metatarsal bones; the toes 10 posterior phalanges, 8 middle phalanges, 10 anterior phalanges, and 6 sesamoid bones.

The bones of the lower extremities are 66.

The whole skeleton contains 259 or 261 bones.

Of the bones just enumerated, the os frontis, spheno-occipitale, ethmoideum, vomer, inferior maxilla, the vertebræ, sacrum, and os coccygis, the bones of the sternum, and the os linguale medium, or body of the os hyoides, are single bones; and being placed in the middle of the body, are consequently symmetrical. Of all the other bones, there is a pair, consisting of a bone for the right, and another for the left side.

The structure of the whole skeleton is therefore symmetrical; since an imaginary perpendicular line drawn through the whole would divide even the single bones into a right and a left half, exactly resembling each other. This observation must however be taken with some allowance; since the corresponding bones of one side are not always perfectly similar to those of the opposite; nor do the two halves of the single bones always exactly agree in form, &c.

The entire natural skeleton of a man of middle stature, in a dried state, weighs from 150 to 200 ounces; that of a woman from 100 to 160 ounces.

Bones of the head.—The cranium is the oval bony cavity containing the brain; the face is placed at the anterior and lower part of this cavity, and holds some of the organs of sense, and the instruments of mastication.

The bones of the head are joined by sutures, a mode of union nearly peculiar to themselves; hence, when all the soft parts are destroyed by maceration, they still remain most firmly connected to each other, excepting the front teeth and the lower jaw. The sutures are formed by numerous sharp and ramified processes of the opposed edges of the different bones, shooting into corresponding vacuities of each other. In some instances, however, the bones seem to be joined by the opposition of plane surfaces, and here the union appears externally like a mere line, instead of the irregular zigzag course which it takes in the former case The last mentioned junction is called harmonia.

In the fœtal state, the bones of the cranium do not touch each other, but are separated by considerable intervals of membrane, and have thin extenuated margins, which allow them to ride over each other when subjected to pressure. The larger and more conspicuous of these intervals are called fontanelles, and allow of the pulsation of the brain being felt in a young subject. The importance of this structure, in allowing the head to accom-

modate itself to the varying figure of the parts through which it passes, in the act of parturition, and to sustain the violent pressure which it experiences in the same act, is sufficiently obvious. In the progress of ossification the edges of the bones meet each other, and become united by the sutures. The use of these in the adult cranium cannot be satisfactorily assigned, nor do we see any difference that would arise, if the head had been composed of one piece only, without any suture. In old persons the sutures often become more or less generally obliterated.

The individual bones are very firmly connected by this mode of union. The edges of the different bones overlap each other at different parts, so that they are mechanically locked together, and cannot be driven in by any force *ab externo.*

The bones of the cranium are composed of two plates of compact bony substance, called the external, and internal or vitreous tables; and an intervening more or less obvious reticular texture, termed diploe. The proportion of these constituent parts varies very considerably; the diploe is in no case of a very loose or open texture. The thickness of individual skulls is subject to great variety; and there is much difference in the various parts of the same skull. For the internal surface is every where exactly moulded to the form of its contents, instead of influencing them, as we might have expected *a priori.* Hence the convolutions of the brain, the vessels which ramify on its surface, &c. all leave prints on the inner table. The ordinary thickness varies from about the fifth of an inch to almost a mere line.

The common number of the bones of the cranium is, as we have already stated, 7: but this is often increased by small portions formed between the others, and surrounded by distinct sutures. These are called ossa, triquetra, or wormiana.

The form of the cranium is elliptical, and pretty regularly so, particularly on the front, upper and back part, and sides. The smaller circle of the ellipse is in front, and the larger behind. It is tolerably smooth, externally, except its basis, and it is almost entire or unperforated, except at the same part. In this situation, however, it possesses numerous holes, or, as they are technically named, foramina, which transmit blood-vessels to the brain, and the nine pairs of nerves which arise from that organ.

The upper and lateral parts of the cranium constitute a bony vault or arch, for protecting the brain: this part is distinguished by the name of the scull cap.

Individual bones of the head.—The os frontis forms the upper and anterior part of the skull, the eyebrow, and the roof of the orbit.

The ossa parietalia are called also ossa bregmatis, since the fontanelles or bregmata are formed between their edges. They compose the whole upper and most of the lateral parts of the skull, and possess an irregularly quadrangular figure.

The ossa temporum compose the lower part of the sides, and the middle of the basis of the cranium. They are divided into a squamous portion, a mamillary, and a petrous portion. The former of these has a process contributing to the zygoma, or bony arch, at the side of the cranium, under which the temporal muscle passes. The second is also remarkable, by forming a large nipple-like protuberance towards the basis cranii. The third, which projects into the cavity of the skull, contains the organ of hearing.

The os spheno-occipitale has generally been described as two bones. The occipital portion forms the posterior portion of the basis cranii, and a part also of the back of the bony case.

The sphenoid portion is situated in the middle of the base of the skull, and extends across it from one temple to another. It is extremely irregular in its figure, and divided into a body placed in the middle, two alæ on the sides, and two pterygoid processes projecting downwards.

The os ethmoides occupies the middle of the forepart of the basis cranii. It lies in the interval between the two orbits, and contributes to the cavity of the nose. It consists of an irregular assemblage of bony cells and processes, of a very thin and delicate formation. It has a cribriform or horizontal plate towards the brain: a nasal or perpendicular plate; 2 turbinated bones; cells; and two orbital plates.

The sutures joining these are the coronal, between the os frontis and the two ossa parietalia; the sagittal, between the two ossa parietalia; the lambdoidal, joining the ossa parietalia to the os occipitis; the squamous, between the temporal and parietal bones.

The foramina occurring in the cranium, for the transmission of nerves, are; 1, those of the cribriform plate of the ethmoid bone: 2, f. optica: 3, f. lacera or bitalia: 4, f. rotunda: 5, f. ovalia: 6, meatus auditorii interni: 7, f. lacera in basi cranii: 8, f. condyloidea anteriora: 9, foramen magnum.

Those which transmit blood vessels are; 1, canales caroctici: 2, f. spinosa: 3, f. lacera in basi cranii: 4, f. magnum.

Bones of the face—The ossa nasi constitute the arch of the nose. The ossa lacrymalia or unguis are placed at the fore-part of the inner edge of the orbits, and contain an excavation which holds the lacrymal bag.

The ossa malarum form the prominences of the cheeks.

The ossa maxillaria superiora form the largest portion of the upper jaw, and most of the bony palate, or roof of the mouth; they contain also the upper teeth.

The ossa palati form tho back part of the bony palate.

The ossa turbinata inferiora are situated in the cavity of the nose.

The former completes, with the nasal portion of the ethmoid, the septum that divides the two nostrils.

The maxilla inferior is articulated to the basis cranii, and holds the lower teeth.

The bones of the cranium and face compose the two orbits, or pyramidal bony cavities, holding the organs of vision; to each of these, seven bones contribute. They also form the cavity of the nose, which is very extensive, and includes portions of nearly all the bones of the face, and some of the skull. It has various cells, formed in the bones of the skull and face, opening into it.

The teeth.—These organs are composed internally of a very hard bony substance; and are covered externally by a still harder matter, called the cortex or enamel. Each tooth has a body or crown, which is the part seen in the mouth; a neck, round which the gum adheres; and one or more fangs or roots, which are sunk in a process of the jaw, called the alveolar. These bodies are not formed in a nidus of cartilage, like bones, but on a soft vascular body, called a pulp, which may be compared to the core, on which a horn is formed. This is surrounded by a delicate membrane, called the capsule of the tooth. When the teeth are being formed, these pulps and capsules, with the rudiments of the teeth, are lodged in cavities hollowed out of the jaw bone. They afterwards rise, and, piercing the gum, appear in the mouth.

Teeth differ from other bones in possessing no vessels nor nerves in their substance. As they are destined for the merely mechanical function of triturating the food, such parts would not have been suitable to this office. The pain of toothach arises from a nerve, which, with a vessel, resides in a hollow, formed in the centre of the fang and body of each tooth. These parts are exposed by the decay. The teeth, in consequence of possessing no vessels, are only affected by chemical and mechanical causes. They do not repair the effects of trituration, nor of accidental injury; nor do they suffer from any of the diseases which affect other bones.

There are two sets of teeth; the first are fewer in number, and smaller in size; as they fall out at a certain age, to make room for other larger ones, they are called deciduous or temporary. The second set lasts throughout life, and are called the adult or permanent set.

The latter consists of 32 teeth; 16 in each jaw. There are four incisores or cutting teeth in front; 2 canini or cuspidati, or dog teeth, placed one on each side of the former; 4 bicuspides behind the last; and 6 molares behind these. From the late period at which the last molaris appears, it is called the dens sapientiæ, or wise tooth.

The temporary set consists of twenty teeth; ten in each jaw. There are 4 incisores; 2 cuspidati; and 4 molares.

The permanent teeth are lodged at first in cavities of the jaw, near the roots of the temporary ones; and, as these last are shed, rise up to supply their places.

The bone of the tongue is called os hyoides, from its very accurate resemblance to the Greek υ. It consists of a body, two cornua, and two appendices, which are in fact so many separate bits of bone.

The bones of the trunk consist of those of the spine, thorax, and pelvis.

The spine consists of twenty-four true or moveable vertebræ; an os sacrum, and an os coccygis (which indeed is composed of four pieces); these last bones, bearing considerable resemblance to the vertebræ, are called sometimes the false vertebræ.

Each vertebra has a body, which is situated anteriorly, and consists of a cylindrical piece of bone; a perforation behind this, in which the spinal marrow runs; two superior and two inferior articulating processes, by which it is joined to the bone immediately above and below it; two transverse processes, and one spinous process, which, projecting behind, forms a sharp ridge, from which the name of spine has been applied to the whole column.

The vertebræ are divided into three classes, according to their situation: the seven upper ones are called cervical: of

these, the first, that immediately supports the head, is called the atlas; and the second, from a remarkable bony process which it possesses, the vertebræ dentata. The twelve next are called dorsal vertebræ, and are distinguished by having the ribs articulated to them. The five last are called lumbar. These all differ from each other in some circumstances. The most obvious distinction arises from the size: the upper ones are the smallest, and there is a gradual increase as we descend.

The column of the spine, when viewed altogether, is not perpendicular; it stands forward in the neck, recedes in the upper part of the back, and projects again in the loins. Holes are left between the bones, for the transmission of the nerves which arise from the spinal marrow.

The sacrum forms the back of the pelvis, and is followed out in front. In form it is triangular, and the base is joined to the last vertebra. It is perforated by a canal, in which the termination of the medulla spinalis is lodged. Its apex has connected to it the os coccygis.

The thorax is formed by the twelve dorsal vertebræ, the ribs, and sternum. The ribs are long, curved, flattened, and narrow bones, attached behind to the dorsal vertebræ, both in their bodies and transverse processes, and joined in front to a piece of cartilage. They are twelve in number, and the seven upper ones, whose cartilages are affixed to the sides of the sternum, are called true ribs; the five lower ones, the cartilages of which do not reach so far, are called the false ribs.

The sternum is a broad and flat bone, placed in the front of the chest. It consists of two pieces of bone, and of a cartilage called the ensiform. The clavicles are articulated towards its upper parts, and the cartilages of the ribs are joined to its sides.

The pelvis is formed by the two ossa innominata, or haunch bones, the sacrum, and os coccygis. The former are very large and flat bones, expanded into a broad surface above for the support of the abdominal viscera, and the attachment of the abdominal muscles, and furnished with large tuberosities below, for the support of the body in the sitting position. Each os innominatum is divided into the ilium, ischium, and pubes. It is firmly joined to the sacrum behind, and to the opposite bone in front, by the symphisis pubis. The conjoined portions form an arch, called the arch of the pubes. The cavity of the pelvis is much larger in the female than in the male, as it holds the uterus and vagina, in addition to what it contains in the male, and as the fœtus passes through it in parturition.

The bones of the upper extremity are distributed into those of the shoulder, arm, fore-arm, and hand.

The shoulder contains two; the scapula and clavicle. The former is situated at the upper and outer part of the chest, and is joined to the end of the clavicle.

The humerus is a long and nearly cylindrical bone, joined by a round head to the scapula above, and articulated with the radius and ulna below.

The fore-arm has two bones; the ulna, which is joined by a hinge or ginglymus to the humerus; and the radius, which has a cavity playing upon a rounded head of that bone. The prominent extremity of the ulna, which forms the elbow, is called the olecranon. The hand is dided into the carpus, or wrist, the metacarpus, and the fingers and thumb.

The carpus contains eight bones, disposed in two phalanges, of which the first forms, with the radius, the joint of the wrist, and the second is articulated to the metacarpus.

The bones of the first phalanx are the os scaphoides, lunare, cuneiforme, and pisiforme: those of the second, os trapezium, trapezioides magnum, and unciforme.

The metacarpus has five bones, and each of the fingers three; the thumb only two.

In the lower extremity we have the femur, the largest of the cylindrical bones in the body. This has a round head, contained in a socket of the os innominatum: the great trochanter forms a conspicuous process at the upper and outer part of the bone. Below it has two condyles, which form part of the knee.

The leg has two bones; the tibia and fibula. A large flat portion of the former, covered only by skin, is called the shin. The foot is composed of the tarsus, metatarsus, and toes. The tarsus has seven bones:—1. Astragalus, composing the ankle, with the lower portion of the tibia and fibula. 2. Os calcis. 3. Os naviculare. 4. Os cuboides. 5, 6, 7. Ossa cuneiformia. The metatarsal bones are five in number, and the bones of each toe are three, except the great toe, which has only two.

SYNDESMOLOGY, OR DOCTRINE OF THE JOINTS.

Construction of a joint.—The opposed surfaces of bones, which form joints, are

covered by a thin crust of cartilage, most exquisitely smooth and polished. Hence they move on each other, in whatever direction their structure admits, without any hindrance from friction. They are tied together by strong and unyielding cords, resembling tendons, and known by the name of ligaments. These keep the surfaces of the bones together, and restrict their motions to certain directions. In order still further to promote the facility of motion, and to obviate every possibility of friction, the cartilaginous surfaces are smeared with an unctuous fluid, called synovia, which makes them perfectly slippery. This fluid is confined to the surface of the joint by means of a thin and delicate membrane, called the capsular ligament, which envelopes the joint. It is secreted from portions of a fatty substance, called the synovial glands. The ligaments are usually situated on the outside of the capsula; but in many instances they are contained in the cavity of the joint, passing from the centre of one bone to another. These are called interarticular ligaments.

Particular joints.—Joint of the lower jaw. This is formed between the condyle of the jaw and a hollow in the temporal bone. It contains a moveable cartilage, which renders the articulation more secure, when the jaw is brought forwards on the bone under certain circumstances.

The connection of the head to the vertebræ is effected by means of two prominences of the occiput, which are received into corresponding cavities of the atlas. By this joint the nodding motions of the head are performed. But the atlas itself turns horizontally round the tooth-like process of the vertebra dentata, and as the head is closely connected to the atlas, it is carried round at the same time. Therefore, the lateral or rotatory motions of the head are performed by a different joint from that which performs the nodding motions. Neither of these articulations admits of very extensive motion; but the deficiency is compensated by the mobility of the vertebræ, which enable us to carry the head freely in any direction we may wish. The head rests nearly in equilibrio on the spinal column; yet, if left to itself, it would fall forwards, as the joint is not precisely in the centre of the basis cranii. To counteract this tendency, there is a ligamentous substance extended from the spinous processes of the cervical vertebræ to the occiput, and called the ligamentum muchæ. In quadrupeds this can be best seen, as the weight of the head is there supported to a much greater disadvantage. The muscles also contribute to keep the head upright; and hence, when a man drops asleep sitting, the relaxation of the extensor muscles causes the head to nod forwards.

Joints of the spine.—The spine, or backbone, is a chain of joints of very wonderful construction. Various, difficult, and almost inconsistent, offices were to be executed by the same instrument. It was to be firm, yet flexible; firm, to support the erect position of the body; flexible, to allow of the bending of the trunk in all degrees of curvature. It was further, also, to become a pipe or conduit for the safe conveyance of a most important part of the animal frame, the spinal marrow; a substance, not only of the first necessity to action, if not to life, but of a nature so delicate and tender, so susceptible, and so impatient of injury, as that any unusual pressure upon it, or any considerable obstruction of its course, is followed by paralysis or death. It was also to afford a fulcrum, stay, or basis, for the insertion of the muscles which are spread over the trunk of the body, in which trunk there are not, as in the limbs, cylindrical bones, to which they can be fastened; and likewise, which is a similar use, to furnish a support for the ends of the ribs to rest upon.

The breadth of the bases, upon which the parts severally rest, and the closeness of the junction, give to the chain its firmness and stability; the number of parts, and consequent frequency of joints, its flexibility; which flexibility, we may also observe, varies in different parts of the chain; is least in the back, where strength more than flexure is wanted; greater in the loins, which it was necessary should be more supple than the back; and greatest of all in the neck, for the free motion of the head. Then, secondly, in order to afford a passage for the descent of the medullary substance, each of these bones is bored through in the middle in such a manner, as that, when put together, the hole in one bone falls into a line and corresponds with the holes in the two bones contiguous to it; by which means the perforated pieces, when joined, form an entire, close, uninterrupted channel. But, as a settled posture is inconsistent with its use, a great difficulty still remained, which was, to prevent the vertebræ from

shifting upon one another, so as to break the line of the canal as often as the body moves or twists, or the joints gaping externally, whenever the body is bent forwards, and the spine thereupon made to take the form of a bow. These dangers, which are mechanical, are mechanically provided against. The vertebræ, by means of their processes and projections, and of the articulations which some of these form with one another at their extremities, are so locked in and confined, as to maintain, in what are called the bodies or broad surfaces of the bones, the relative position nearly unaltered; and to throw the change and the pressure produced by flexion almost entirely upon the intervening cartilages, the springiness and yielding nature of whose substance admits of all the motion which is necessary to be performed upon them, without any chasm being produced by a separation of the parts. I say of all the motion which is necessary; for, although we bend our backs to every degree almost of inclination, the motion of each vertebræ is very small: such is the advantage which we receive from the chain being composed of so many links. Had it been composed of three or four bones only, in bending the body the spinal marrow must have been bruised at every angle.

The substances which connect the bodies of the vertebræ to each other, called the intervertebral cartilages, are thick, firm, and elastic. They are similar in shape, and nearly so in size, to the bones which they join. They are thicker before than behind, so that, when we stoop forwards, the compressible cartilage, yielding to the force, brings the surfaces of the adjoining vertebræ nearer to a state of parallelism than they were before, instead of increasing the inclination of their planes, which must have occasioned a fissure or opening between them: and their elasticity restores the body to its former state, when the compressing force ceases.

In order still further to increase the strength of the compages, and to add a greater security against luxation, the vertebræ are articulated to each other by means of the processes before mentioned. And these processes so lock in with and overwrap one another, as to secure the body of the vertebra, not only from accidentally slipping, but even from being pushed out of its place by any violence short of that which would break the bone. The roots of the spinous processes are also joined to each other by very strong and highly elastic ligamentous substances, which will tend powerfully to restore the column after it has been bent forwards.

The general result is, that not only the motions of the human body, necessary for the ordinary offices of life, are performed with safety, but that it is an accident hardly ever heard of, that even the gesticulations of a harlequin distort his spine.

The ribs are articulated by their posterior extremities to the bodies and to the transverse processes of the vertebræ, and the true ribs are also joined by means of their cartilages to the sternum. Two great advantages are derived from the ribs having this cartilaginous portion. The effect of blows, or of any accidental violence, is eluded, by the flexibility which they thus obtain; and the elastic power of the cartilages restores the ribs to their former position, after they have been raised by the intercostal muscles in breathing.

Joints of the upper extremity.—The clavicle is articulated to the sternum at one end, and to the scapula at the other.

The shoulder is formed by a round head of the humerus, which plays in a cup of the scapula; and the ends of the bones are inclosed by a thick and strong ligamentous membrane, called the orbicular ligament. There is here, therefore, every latitude of motion allowed.

In the elbow, on the contrary, the joint is a mere hinge: lateral motion is restrained by strong ligaments placed at the sides of the joint, and the fore-arm can therefore be moved only forwards and backwards. This joint is formed between the ulna and the humerus.

The wrist is formed by the junction of the radius with the first phalanx of carpal bones. Its motion is very little more than that of a ginglymus. The rotation of the hand and wrist, or what anatomists call the pronation and supination, are performed by the radius revolving round the ulna, and carrying the hand with it. In this case the elbow joint is fixed; neither does the joint of the wrist move; but the radius moves freely round the ulna, and the hand is included in the motion. The pronation and supination of the hand are well exemplified in the use of the broadsword, and in cudgel-playing.

The carpal and metacarpal bones are united by joints and ligaments, but have no obvious motion on each other. The phalanges of the fingers are also articulated by ginglymi.

The bones of the pelvis are inseparably

connected by adhering cartilaginous surfaces and immense ligaments. Such is the strength of this union, that it will yield to no force but one that would destroy and crush the whole fabric.

Joints of the lower extremity.—In the hip, which supports the whole body, and which is the centre of motion of the whole in moving from place to place, we find an apparatus, admitting of extensive motion, but at the same time most carefully guarded and strengthened. There is a very large rounded head of the thigh received into a deep cup of the os innominatum. Here it can revolve freely, and is prevented from escaping by thick and strong rising edges, that guard the brim of the cavity. From these edges there springs a very tough and stout orbicular ligament, which is firmly stretched over the head of the bone, and implanted into a contracted part called the neck. In order to provide still further for the security of so important a joint as the hip, there is a short, strong ligament arising from the head of the ball, and implanted in the bottom of the cup. This affords a very great obstacle to any force tending to displace the bone; but at the same time lies in the bottom of the cavity, so as not to interfere with any of the ordinary motions.

The knee-joint is formed by three bones: the head of the tibia, the condyles of the femur, and the patella. It is a ginglymus, and its motions are accordingly restrained by two strong lateral ligaments, and it is secured still further by two immense ligamentous ropes within the cavity of the joint, called the crucial ligaments.

The ankle is a ginglymoid joint, formed by the tibia and fibula, together with the astragalus. This joint, which is an important one, as bearing the weight of the whole body, is strengthened at its sides by two bony processes, called the internal and external malleoli or ankles.

The bones of the tarsus, metatarsus, and toes, are articulated, like those of the hand.

MYOLOGY.

Muscles consist of bundles of red fibres; but the colour is not essential, since it can be removed by repeated washings and maceration.

The threads composing a muscle are enveloped by cellular substance, which connects it to the surrounding parts. Each bundle consists of numerous fibres, so small, that our instruments of research cannot arrive at the ultimate or original fibre: hence, any perceivable fibre, however small, is formed by the juxta-position of numerous fibrillæ; and, as we employ magnifying instruments of greater power, a fibre, which before seemed simple, resolves itself into a congeries of still more minute threads. We pass over in silence the dreams of various investigators, who have busied themselves in looking for the ultimate muscular fibre; these researches do not assist us in explaining the phenomena of muscular action. The cohesion of the constituent particles of the moving fibre is maintained by the vital power: hence, a dead muscle will be torn by a weight of a few ounces, which in the living body would have supported many pounds. The muscular fibre receives a copious supply of vessels and nerves.

Tendons are formed by an assemblage of longitudinal parallel fibres. They are extremely dense and tough, of a splendid white colour, which is beautifully contrasted with the florid red of a healthy muscle. The muscular fibres terminate in these bodies, and they are connected to the bones. They possess no apparent nerves, and very few and small blood-vessels.

There is always an exact relation between the joint and the muscles that move it. Whatever motion the joint, by its mechanical construction, is capable of performing, that motion the annexed muscles, by their position, are capable of producing. For example, if there be, as at the knee and elbow, a hinge joint, capable of motion only in the same plane, the muscles and tendons are placed in directions parallel to the bone, so as by their construction to produce that motion, and no other. If these joints were capable of freer motion, there are no muscles to produce it. Whereas, at the shoulder and the hip, where the ball and socket joint allows by its construction a rotatory or sweeping motion, tendons are placed in such a position, and pull in such a direction, as to produce the motion of which the joint admits. In the head and hand, there is a specific mechanism in the bones for rotatory motion; and there is accordingly, in the oblique direction of the muscles belonging to them, a specific provision for putting this mechanism of the bones into action. The oblique muscles would have been inefficient without that particular articulation, and that particular articulation would have been useless without the muscles.

As the muscles act only by contraction, it is evident that the reciprocal energetic

motion of the limbs, or their motion with force in opposite directions, can only be produced by the instrumentality of opposite or antagonist muscles, of flexors and extensors answering to each other. For instance, the biceps and brachialis internus, placed in the front of the arm, by their contraction, bend the elbow, and with such degree of force as the case requires, or the strength admits of. The relaxation of these muscles after the effort would merely let the fore-arm drop down: for the back stroke, therefore, and that the arm may not only bend at the elbow, but also extend and straigthen itself with force, other muscles, as the triceps and anconeus, placed on the hinder part of the arm, fetch back the fore-arm into a straight line with the humerus, with no less force than that with which it was bent out of it. It is evident, therefore, that the animal functions require that particular disposition of the muscles which we call antagonist muscles.

It often happens that the action of muscles is wanted, where their situation would be inconvenient. In which case, the body of the muscle is placed in some commodious position at a distance, and it communicates with the point of action by slender tendons. If the muscles which move the fingers had been placed in the palm or back of the hand, they would have swelled that part to an awkward and clumsy thickness. The beauty, the proportions of the part, would have been destroyed. They are therefore disposed in the arm, and even up to the elbow, and act by long tendons strapped down at the wrist, and passing under the ligament to the fingers, and to the joints of the fingers, which they are severally to move. In the same manner the muscles, which move the toes and many of the joints of the foot, are gracefully disposed in the calf of the leg, instead of forming an unwieldy tumefaction in the foot itself.

The great mechanical variety in the figure of the muscles may be thus stated. It appears to be a fixed law, that the contraction of a muscle shall be towards its centre. Therefore the subject for mechanism on each occasion is, so to modify the figure, and adjust the position of the muscle, as to produce the motion required, agreeably with this law. This can only be done by giving to different muscles a diversity of configuration, suited to their several offices, and to their situation with respect to the work which they have to perform. On which account we find them under a multiplicity of forms and attitudes; sometimes with double, sometimes with treble tendons, sometimes with none; sometimes one tendon to several muscles, at other times one muscle to several tendons. The shape of the organ is susceptible of an incalculable variety, whilst the original property of the muscle, the law and line of its contraction, remains the same, and is simple. Herein the muscular system may be said to bear a perfect resemblance to our works of art. An artist does not alter the native quality of his materials, or their laws of action. He takes these as he finds them. His skill and ingenuity are employed in turning them, such as they are, to his account, by giving to the parts of his machine a form and relation, in which these unalterable properties may operate to the production of the effects intended.

The muscular system would afford us numerous examples of what may be called mechanical structure: *i. e.* of such contrivances, employed to attain certain objects, as a human artist would adopt on similar occasions. One of the muscles of the eye-ball presents us with a very perfect pulley; by means of which the globe of the eye is moved in a direction exactly contrary to the original application of the force. This muscle, which is called the trochlearis, arises from the very back part of the orbit: it has a long and slender tendon, running through a pulley in the inner part of the front margin of the orbit, and then going back to be fixed in the hind portion of the eye-ball. Thus it draws the globe obliquely upwards and forwards, although the line of the contraction of the muscle is directly backward.

In the toes and fingers, the long tendon, which bends the first joint, passes through the short tendon, which bends the second joint.

The foot is placed at a considerable angle with the leg. It is manifest, therefore, that flexible strings, passing along the interior of the angle, if left to themselves, would, when stretched, start from it. The obvious preventive is to tie them down, and this is done in fact. Across the instep, or rather just above it, the anatomist finds a strong ligament, under which the tendons pass to the foot. The effect of the ligament, as a bandage, can be made evident to the senses; for if it be cut, the tendons start up. The simplicity, yet the clearness of this contrivance, its exact resemblance to established resources of art, place it among the

most indubitable manifestations of design with which we are acquainted.

The number of the muscles of the human body is so great, and the circumstances which demand attention in every muscle are likewise so numerous, that a particular description of each would extend this article beyond its prescribed limits. We shall therefore merely give a catalogue of the muscles; which, together with the references to the annexed plates, will give the reader a sufficiently clear notion of the subject.

Muscles of the scalp.—1. Fronto-occipitalis, or epicranius.

Muscles of the ear.—1. Attollens auriculam; 2. anterior auris; 3, 4. retrahentes auriculam; 5. major helicis; 6. minor helicis; 7. tragicus; 8. antitragicus; 9. transversus auriculæ; 10. laxator tympani major; 11. laxator tympani minor; 12. tensor tympani; 13. stapedeus.

Muscles of the eye.—1. Orbicularis palpebrarum; 2. corrugator supercilii; 3. levator palpebræ superioris; 4. attollens oculi; 5. abductor oculi; 6. depressor oculi; 7. adductor oculi: these are also called recti; *viz.* rectus superior, externus, inferior, and internus; 8. obliquus superior oculi, or trochlearis; 9. obliquus inferior oculi.

Muscles of the nose.—1. Compressor narium; 2. levator labii superioris et alæ nasi; 3. nasalis labii superioris; 4. depressor alæ nasi.

Muscles of the lips.—1. Levator labii superioris; 2. zygomaticus major; 3. zygomaticus minor; 4. levator anguli oris; 5. depressor anguli oris; 6. depressor labii inferioris; 7. buccinator; 8. orbicularis oris; 9. anomalus maxillæ superioris; 10. levator menti.

Lower jaw.—1. Biventer maxillæ, or digastricus; 2. masseter; 3. temporalis; 4. pterygoideus externus; 5. pterygoideus internus.

Neck.—1. Latissimus colli, or platysma myoides; 2. sterno-cleido-mastoideus.

Tongue and thyroid cartilage.—1. Omohyoideus; 2. sternohyoideus; 3. sternothyreoideus; 4. hyothyreoideus; 5. musculus glandulæ thyreoideæ; 6. stylohyoideus; 7. styloglossus; 8. mylohyoideus; 9. geniohyoideus; 10. hyoglossus; 11. genioglossus; 12. lingualis.

Muscles of the pharynx and palate.—1. Stylopharyngeus; 2. constrictor pharyngis superior; 3. constrictor medius; 4. constrictor inferior; 5. salpingo-pharyngeus; 6. palato-pharyngeus; 7. constrictor isthmi faucium; 8. levator palati mollis; 9. circumflexus palati; 10. azygus uvulæ.

Muscles of the larynx.—1. Cricothyreoideus; 2. crico-arytenoideus posticus; 3. crico-arytenoideus lateralis; 4. arytenoideus obliquus; 5. arytenoideus transversus; 6. thyreo-arytenoideus; 7. thyreo-epiglotticus.

The whole number of muscles about the head, neck, and throat, is therefore 72.

Muscles of the abdomen.—1. Obliquus externus abdominis; 2. obliquus internus abdominis; 3. transversalis abdominis; 4. rectus abdominis; 5. pyramidalis; 6. diaphragma or septum transversum.

Muscles of the thorax.—1. Sterno costalis, or triangularis sterni; 2. serratus posticus superior; 3. serratus posticus inferior; 4, 5, 6. scalenus anterior, medius, and posterior; 7 to 18. levatores breviores costarum; 19 to 21. levatores longiores costarum; 22. intercostales externi; 23. intercostales interni; 24. quadratus lumborum.

Muscles moving the head and spine.—1. Splenius capitis; 2. splenius cervicis; 3. biventer cervicis; 4. complexus; 5. trachelomastoideus; 6. transversus cervicis; 7. cervicis descendens; 8. longissimus dorsi; 9. sacrolumbalis; 10. spinalis cervicis; 11. spinalis dorsi; 12. multifidus spinæ; 13 to 22. interspinales cervicis; 23 to 28. interspinales lumborum; 29. rectus capitis posticus major; 30. rectus capitis posticus minor; 31. obliquus capitis superior; 32. obliquus capitis inferior; 33. rectus lateralis; 34. rectus capitis anticus major; 35. rectus anticus minor; 36. longus colli; 37 to 43. intertransversi colli priores; 44 to 49. intertransversi colli posteriores; 50 to 57. intertransversi dorsi; 58 to 62. intertransversi lumborum.

Muscles of the anus and perineum.—1. transversus perinei; 2. transversus perinei alter; 3. sphincter ani; 4. levator ani; 5. musculus coccygeus; 6, curvator coccygis.

Muscles peculiar to the male organs of generation.—1. Cremaster; 2. erector penis; 3. accelerator; 4. compressor prostatæ.

Muscles peculiar to the female organs of generation.—1. Erector clitoridis; 2. sphincter vaginæ; 3. depressor urethræ.

The whole number of muscles of the trunk 105.

Muscles of the upper extremity.—Shoulder. 1. Pectoralis major; 2. pectoralis minor; 3. subclavius; 4. serratus magnus; 5. trepazius; 6. latissimus dorsi; 7. rhomboideus minor; 8. rhomboideus major; 9. levator anguli scapulæ; 10.

deltoides; 11. supraspinatus; 12. infraspinatus; 13. teres major; 14. teres minor; 15. subscapularis.

Arm.—1. Biceps flexor cubiti; 2. brachialis internus; 3. coracobrachialis; 4. triceps extensor cubiti; 5. anconeus.

Fore-arm.—1. supinator radii longus; 2, 3. extensor carpi radialis longior et brevior; 4. extensor carpi ulnaris; 5. extensor communis digitorum manus; 6. extensor proprius auricularis; 7. abductor longus pollicis manus; 8. extensor major pollicis manus; 9. extensor minor pollicis; 10. indicator; 11. flexor carpi ulnaris; 12. palmaris longus; 13. flexor carpi radialis; 14. pronator radii teres; 15. flexor digitorum sublimis, or perforatus; 16. flexor profundus, or perforans; 17 to 20. musculi lumbricales; 21. flexor longus pollicis manus; 22. supinator radii brevis; 23. pronator radii quadratus.

Muscles of the hand.—1. abductor brevis pollicis manus; 2. opponens pollicis manus; 3. flexor brevis pollicis; 4. abductor pollicis; 5. palmaris brevis; 6. abductor digiti minimi; 7. flexor proprius digiti minimi; 8. abductor ossis metacarpi digiti minimi; 9 to 11. interossei interni manus; 12 to 15. interossei externi manus.

The muscles of the upper extremity are 58.

Muscles of the thigh.—1. Tensor fasciæ latæ; 2. glutens maximus; 3. gluteus medius; 4. gluteus minimus; 5. pyriformis; 6, 7. geminus superior and inferior; 8. obturator internus; 9. quadratus femoris; 10. biceps flexor cruris; 11. semitendinosus; 12. semimembranosus; 13. psoas minor; 14. psoas major; 15. iliacus internus; 16. sartorius; 17. gracilis; 18. rectus extensor cruris; 19. vastus externus; 20. vastus internus; 21. cruralis; 22. pectineus; 23. triceps adductor femoris; 24. obturator externus.

Muscles of the leg.—1. Gastrocnemius or gemellus; 2. soleus; 3. plantaris; 4. popliteus; 5. flexor longus digitorum pedis; 6 to 9. lumbricales pedis; 10. flexor longus hallucis; 11. tibialis posticus; 12. peroneus longus; 13. peroneus brevis; 14. tibialis anticus; 15. extensor longus digitorum pedis; 16. peroneus tertius.

Muscles of the foot.—1. Extensor proprius hallucis; 2. extensor brevis digitorum pedis; 3. flexor brevis digitorum pedis; 4. abductor hallucis; 5. transversus pedis; 6. abductor digiti minimi pedis; 7. flexor brevis digiti minimi pedis; 8 to 10. interossei interni pedis; 11 to 14, interossei externi pedis.

The muscles of the lower extremity are 54; and the whole number of the body 289. But as they are the same on both sides, this must be doubled, which will give 578; an enumeration which is pretty nearly correct.

ORGANS CONCERNED IN THE REDUCTION AND ASSIMILATION OF THE FOOD.

Organs of mastication and deglutition.—The two jaws, with their teeth, and the tongue, are the principal agents in the business of mastication.

The articulation of the condyle of the lower jaw with the glenoid cavity of the temporal bone admits of the former part being moved in various directions. Its depression and elevation cause the opening and shutting of the mouth. It can be brought forwards, and carried backwards; and admits also of being moved to one side or the other. It is by a combination of these various motions that the food is masticated, or reduced into a soft and pulpy form. The different teeth which are placed in various parts of the cavity of the mouth are adapted, by their form and situation, for various parts of the process of mastication. The anterior ones, which have a thin cutting edge, and in which the superior overlap the inferior, act like the blades of a pair of scissors. These cut the food into smaller morsels; and serve us also in biting off a portion from any mass of food which we may be eating. The back teeth have broad bases, furnished with obtuse prominences; and they shut perpendicularly on each other. These are therefore well adapted for the grinding and trituration of the food. As their office requires a greater muscular force, they are placed in the back of the mouth, near to the centre of motion, and where, consequently, the action of the muscles is felt with the greatest effect. The cutting teeth are placed in front, at a greater distance from the attachment of the muscles, because their office does not require so great a muscular exertion.

The tongue is of considerable utility in contributing to mastication, as it serves to move the food about in the cavity of the mouth, and to subject it again to the action of the grinding teeth, when it has escaped from between their surfaces. The muscles of this organ, which we have enumerated in the myological division of the article, give it a power of motion in every direction.

But the simple act of mastication would

only reduce the food into a powder, or at all events into a dry mass, that could not be swallowed without great difficulty. To obviate this inconvenience, it is plentifully moistened with a watery fluid called saliva, and is thereby converted into a soft paste, which can be conveyed into the stomach with perfect facility. The source of this fluid is, in several glandular bodies, situated near the mouth, and sending excretory ducts, which convey the secreted fluid into that cavity. As the jaws move, the muscles compress these glands, and squeeze the secreted fluid into the mouth. The tongue is constantly employed in bringing again under the action of the teeth those portions of the food which escape from between them; and the closure of the lips prevents it from falling out of the mouth.

The true salivary glands are three in number, on each side of the head. The largest is placed in the space left between the ear and the lower-jaw-bone; and is called, from its situation, the parotid. Its duct pierces the middle of the cheek. The two others are placed under the tongue, and are called the submaxillary and sublingual. Their ducts join to open by a common orifice, at the side of the membrane called the frenum of the tongue, which ties the under surface of that organ to the inside of the lower jaw. Besides these large salivary glands, there are other small granular bodies, which pour a mucous fluid into the mouth; these are named, according to their situation, glandulæ labiales, buccales, &c.

The cavity of the mouth in which the process of mastication goes on is not a very extensive one. There is a small space left between the cheeks and the teeth externally; but within the teeth the tongue occupies nearly the whole room. The upper boundary is formed by the palate or roof of the mouth, and the lower by the surface of the tongue. The mouth opens behind, by a tolerable free communication, into a membranous bag, called the pharynx. The surface of the mouth is every where covered by a soft and smooth membrane. This is of course kept constantly in a moist state, as the glands above enumerated continually pour more or less of their secretion into the cavity. The membrane of the mouth is continuous with the external surface of the body; but the skin assumes a more delicate organization, as must be apparent to every body, from the change of colour at the lips.

Bag of the pharynx.—The masticated aliment is collected on the back of the tongue, which is then carried upwards, and backwards, to discharge it into the pharynx. This bag is covered by muscular fibres (forming the muscles called constrictores pharyngis) which contract, successively, in order to propel the food towards the stomach. But as there are several organs communicating with the pharynx, the food might pass in a wrong direction, if the parts were not so contrived as to prevent such occurrences.

In the upper and anterior part of the pharynx, the nostrils open by two large and free apertures. Between these and the entrance from the mouth is found a fleshy and moveable curtain, called the soft palate, or velum pendulum palati. There is a small body, of a pointed figure, projecting from the middle of this organ, and known by the name of the uvula. This curtain and the uvula can be easily seen in the throat of a living person. It admits of being elevated so as to shut the opening of the nostrils; and its action is exemplified in the act of vomiting: the food is forcibly thrown into the pharynx, and would pass mostly into the nose, were it not prevented by the soft palate. From the uvula the membrane is continued on either side, in an arched form, towards the root of the tongue, and it contains a glandular body, called the tonsil, which secretes a mucous fluid, to lubricate the parts, and facilitate the passage of the aliment. The larynx opens into the pharynx, just at the root of the tongue; over this part, which is termed the glottis, every morsel of the food must necessarily pass; yet, so exquisitely tender is the membrane of the wind pipe, that the contact of the smallest extraneous body excites a convulsive paroxysm of coughing, that does not cease until the offending matter be removed. Here then are two objects to be effected; the function of respiration requires that the windpipe should have a free communication with the external air, while the irritable nature of its membrane demands that no extraneous body should find admission. These points are both attained by means of a strictly mechanical contrivance; by a structure which produces the required effect, independently of the will of the animal, and merely in consequence of those motions which the organs perform in the office of deglutition. At the back of the tongue, and just in front of the glottis, is a cartilaginous valve, called the epiglottis. When the parts are at rest, this valve stands perpendicular, and con-

sequently does not interfere with the passage of the air into the wind-pipe. In the act of swallowing, the tongue is carried backwards, and the wind-pipe is drawn up: hence the epiglottis becomes mechanically applied over the opening, and at this moment the food enters the pharynx over it, and by its pressure closes the aperture still more completely. As soon as the food has passed, the tongue and wind-pipe resume their former position, the elasticity of the cartilage restores it to the erect state, and the glottis is again free for the continuance of respiration. So completely does this simple mechanism answer the proposed end, that, although every morsel of food passes over the glottis, the accident of any portion going the wrong way, as it is termed, is comparatively rare, and can only arise from our being imprudent enough to laugh or talk while we are swallowing. In either of these cases air must pass out of the trachea, and, by so doing, it lifts up the epiglottis.

The pharynx opens below in the œsophagus, a muscular tube, which conveys the food into the stomach. The aliment, in its farther progress, goes through different viscera contained in the abdomen; and we shall therefore proceed with a description of that cavity.

The term *abdomen* includes a large portion of the body. It is bounded above by the cartilages of the ribs, and by the diaphragm, which separates it from the chest, at the back part, by the bodies of the lumbar vertebra; in front and at the sides, by the abdominal muscles; and below, by the bones of the pelvis.

It is every where lined by a membrane called the peritoneum. The surface of this is perfectly smooth and polished, and moistened by a serous exhalation produced by the minute arteries of the part. This membrane not only lines the cavity of the abdomen, but also covers all the viscera contained in that cavity, so that the exterior surface of each part consists of what anatomists call its peritoneal coat. Hence the motions of these parts upon each other, and upon the surface of the cavity, are performed with perfect facility. The productions of the membrane, which gives these exterior investments to the viscera, serve also to confine them in their relative positions.

The cavity is subdivided into three regions, the epigastric, which includes all the space above an imaginary line drawn across the belly, from the greatest convexities of the cartilages of the seventh true rib; the umbilical, which is the division between this line and another drawn from the anterior superior spines of the ilia; and the hypogastric, which is the space left below the last line.

The sides of the epigastric region, which are the spaces covered by the cartilages of the ribs, are called hypochondria: the sides of the umbilical region are named the loins: and those of the hypogastric the groins.

The stomach is a large membraneous reservoir, receiving the food from the œsophagus, and retaining it until a certain change, called *digestion*, is produced. Its figure is conical, as it is largest at the left end, and gradually decreases in size towards the right: these are called the greater and smaller extremities of the stomach. It is also bent in its course, so that we describe a greater and smaller curvature or arch. It has two openings, one close to the diaphragm, called the cardiac, superior, or œsophageal; the other, just at the smaller end, is called the pyloric, or lower orifice. The capacity of the stomach varies from about 5 to 11 pints.

Its structure is muscular; and this is necessary in order to propel the food when digested. Under the muscular coat is found the internal, or villous, tunic; the arteries of which pour out the gastric juice, the chief agent in the digestion of the food.

The pylorus, which word is derived from two Greek terms, signifying the *keeper of the gate*, is a contracted ring, by which the stomach communicates with the small intestine. It prevents the food from passing out of the stomach before it has been sufficiently acted on by the gastric juice,

The stomach receives a portion of peritoneum as the œsophagus passes the diaphragm. There is also a process coming from the liver, called the lesser omentum, or mesogaster. This is attached to the lesser arch of the stomach. The great omentum, or the caul, is affixed to the greater arch of the stomach, and hangs from thence over the surface of the intestines, being interposed between them and the parietes. It is also attached to a part of the colon: its use is unknown.

The small intestine is divided into three parts; the duodenum, jejunum, and ileum; but this distinction is an arbitrary one, and not founded on any difference in structure. It consists of a membranous tube, about an inch, or an inch and a half in diameter, and four times the length of the subject. Notwithstanding this great length, it is collected, by means of numerous turn-

ings and convolutions, into a comparatively small space. These convolutions of the small intestine occupy the chief part of the umbilical and hypogastric regions of the abdomen. They are connected in their situation by means of a broad folded membrane, called the mesentery. This production of the peritoneum is about six inches broad at its commencement, but it expands gradually, something after the manner of a fan, so that it becomes broad enough, ultimately, to cover the whole length of the small intestine. It serves to keep the different convolutions of the canal in a certain relative position, and allows, at the same time, a considerable freedom of motion, without any danger of intangling. In tracing the course of the small intestine, we follow the duodenum from the lesser extremity of the stomach, in the right hypochondrium, making three turns close on the backbone, and then coming out just over the left kidney. The general direction of the canal from this point, independently of its various turnings and windings, is towards the right groin, where the ilium terminates by entering the cœcum.

The small intestine possesses three coats similar to those of the stomach, *viz.* an external or peritoneal; a middle or muscular; and an internal, or villous, tunic. The latter forms a great many transverse, loose, and floating processes, called valvulæ conniventes; by means of which the extent of surface of the villous coat is very much augmented. Numerous glandular bodies are found in parts of the canal, collected into small parcels, and hence called glandulæ agminatæ.

The food which is reduced by the action of the stomach into an homogeneous mass, called chyme, enters the small intestine, where it undergoes a further change, and becomes chyle. It is propelled along the canal by the muscular coat of the intestine, and the villous tunic absorbs from it the nutritious particles. It passes along every turn and winding of this long canal, continually subjected to the action of the absorbing vessels. The residue of the alimentary matter is sent into the large intestine, from which it is expelled in the form of fæces.

The large intestine is a canal of about two or three inches in diameter, and seven feet in length. It is divided into the cœcum, colon, and rectum. The cœcum is a bag situated in the right groin, and receiving the termination of the ilium. The latter interstice enters in such a manner, that the passage of the aliment is allowed from it into the cœcum, but prevented from returning. The part which effects this is called the valvula coli. A small process, about equal in size to an earthworm, is connected to the cœcum. It is called appendix cœci vermiformis, and its use is unknown.

From the right groin the intestine ascends on the right side of the abdomen over the kidney, under the name of colon: it turns completely over the abdomen at the upper part, and descends along the left side to the left groin; here it makes a large turn over the brim of the pelvis, and enters that cavity, where it takes the name of rectum, which terminates at the anus. We distinguish in the colon the right or ascending portion; the middle or transverse arch; the left or descending; and the sigmoid flexure. The right and left portions of this gut are closely bound down in their situations by two portions of peritoneum, called ligamenti coli. The transverse arch has a broad process connected to it, by which it is loosely attached: this is called the mesocolon.

The large intestines have a peritoneal, a muscular, and a villous coat; but they have no valvulæ conniventes. The longitudinal muscular fibres are collected into three bands, which, being shorter than the rest of the intestine, occasion the other coats to be gathered up in folds between them, and thereby give the intestine a sacculated appearance.

The residue of the alimentary matter, which the large intestine receives from the small, in converted in the former canal into a substance of peculiar odour, colour, and consistence, called fæces; in which form it is expelled from the body.

Parts subservient to the functions of the alimentary canal, and contained in the cavity of the abdomen.

The liver is the largest glandular mass in the body, and is placed towards the right side of the epigastric region. Its thickest portion fills the right hypochondrium; a thinner part of the gland extends across the middle of the epigastric region to the left hypochondrium. Its size is greater in proportion as the animal is younger. In the adult it is contained within the cartilages of the ribs; but in the fœtus it extends to the navel, and fills half the belly. Its upper surface is convex, and in close contact with the concave under surface of the diaphragm. Its under or concave surface rests chiefly on the stomach. It is divided into a right and left lobe, and lobulus spigelii. It has a

posterior and thick, an anterior and thin, margin. Its colour, in the most healthy state, is of a reddish brown; but it often deviates from this. Its weight, in an adult man of middling stature, is about 3 pounds. It is connected to the diaphragm by four ligaments, *viz*. 1. ligamentum latum, or suspensorium, which divides the right and left lobes from each other. The front edge of this part contains the fibrous remains of the umbilical cord of the fœtus, which, assuming the appearance of a round rope, is called the round ligament. 2, 3. Ligamenta lateralia, or dextrum, et sinistrum. 4. Ligamentum coronarium.

The liver is covered exteriorly by peritoneum, and there are certain fissures and excavations on its surface. 1. Fossa, for the gall-bladder, in the under surface of the right lobe. 2. Fissure on the anterior thin margin, for the entrance of the umbilical vein. 3. Portæ, or large transverse notch, at which the blood-vessels enter, and from which the hepatic duct proceeds. 4. Notch for the inferior vena cava. 5. Excavation for the bodies of the vertebræ.

The liver is composed of a tolerably firm and close substance, consisting of a closely united congeries of different vessels. These vessels are the vena portarum, the hepatic artery, the hepatic veins, and the biliary ducts. The former vessel carries to the liver the blood which has circulated through the different abdominal viscera. It ramifies in the liver like an artery, and the secretion of the bile is supposed to take place from the blood which it conveys to the liver. The blood of this vein, as well as that brought by the hepatic artery, for the nourishment of the liver, is returned by the large hepatic veins to the inferior vena cava. The small branches of the hepatic duct, which conveys the secreted bile from the liver, appear like small yellow pores, when a section of the liver is made, and hence they are called pori biliarii.

The mesogaster, or little omentum, is attached to the portæ of the liver. The vena portarum, the biliary ducts, the hepatic artery, and the hepatic plexus of nerves, pass along the right side of this process; and the part in which they are situated is called the capsula Glissoni. Under the edge of this part is an opening, leading to the bag of the great omentum, and called the foramen epiploicum.

GALL-BLADDER AND BILIARY DUCTS.

The gall-bladder is a membranous bag, serving as a reservoir for the bile. Its shape is that of a pear, being broader at one end, and diminishing conically towards the opposite extremity. The broad end is called the fundus; and the smaller part of the neck the viscus. Its average capacity may be about one ounce. It is firmly bound to the surface of the liver by peritoneum. Its inner surface is elegantly reticulated, and furnishes a viscid mucus that mingles with the bile.

The hepatic duct is continued in a straight course from the liver to the duodenum, in which it opens. It passes, however, in an oblique manner, between the coats of the intestine, before opening into its cavity. Hence the contents of the intestine cannot enter the duct; and the more fully the intestine is distended, the more completely is this prevented by the compression of the duct between the intestinal tunics. The neck of the gall-bladder is gradually contracted into a small tube, called the cystic duct, which joins the hepatic at an acute angle, after first running parallel with it. The remainder of the hepatic duct, after the junction with the cystic, is often called the ductus communis choledochus. The surface of the cystic duct, as well as that of the neck of the gall-bladder, has numerous small folds of the internal membrane, which must retard and obstruct the course of the bile.

Pancreas.—Is a gland of the conglomerate kind; that is, composed of numerous minute portions, united by cellular substance. It is connected by one end to the commencement of the duodenum, and extends across the vertebræ, behind the lesser arch of the stomach, to the spleen. Its length is about six inches; its breadth one and a half; and its thickness half an inch.

Each of the small molecules which compose this gland has an excretory duct; these unite together into larger and larger trunks, and the main tube of all runs along the centre of the gland, and joins the ductus communis choledochus just before that duct opens into the duodenum.

Spleen.—This part, which in common language is called the milt, is a soft and livid mass, interposed between the great end of the stomach and the diaphragm. It weighs about six or seven ounces. It consists of a congeries of cells filled with blood, as the arteries and veins of the organ communicate with them. It is closely connected to the great end of the stomach by vascular ramifications, which the splenic vessels send to the stomach. It has a concave and convex surface; an anterior and posterior extremity; and an external peritoneal covering.

ORGANS OF RESPIRATION.

As these are contained in the cavity of the thorax, we shall consider the subject in the form of a description of that cavity and its contents.

The cavity of the thorax is the space included by the dorsal vertebræ behind, by the ribs with their cartilages, the sternum, and intercostal muscles, at the sides and fore part; and by the diaphragm below. This cavity is lined by a membrane called the pleura, which has a smooth internal surface, constantly moistened by a serous exhalation.

The cavity of the chest contains two distinct membranous bags, called the right and left bags of the pleura; each of these holds the lung of its own side, and is entirely separated from the opposite one. The pleura not only forms a bag which holds the lung, but is also reflected over the surface of the viscus, bestowing on it a smooth exterior investment. This is called the pleura pulmonalis, to distinguish it from the other, which is named pleura costalis.

If the cartilages of the ribs be divided on one side of the chest, the corresponding bag of the pleura will be opened; and it will then appear, that this is separated from the opposite one by a partition, which extends from the sternum in front to the vertebræ behind, and is known by the name of mediastinum. The pleura may be compared to two bladders placed laterally with respect to each other, but adhering only partially, and separated by various intervening bodies. Thus, the heart and adjoining large blood-vessels, the œsophagus, and the division of the trachea into the two bronchi, are placed between the two pleuræ. The mediastinum then is the space included between the opposed surfaces of the two bags of the pleuræ, and containing the parts above mentioned. The name of anterior mediastinum is applied to a small interval left between the two pleuræ, just behind the sternum, and occupied only by a loose cellular texture. The posterior mediastinum is a larger space in front of the bodies of the vertebræ; it contains the descending aorta, the vena azygos, thoracic duct, œsophagus, and the par vagum.

The capacity of the chest taken altogether varies, according as we estimate it in a state of inspiration or expiration; being largest in the former, and smallest in the latter state. The right bag of the pleura is considerably larger than the left, as is also the right lung.

In the living state, the lung is in close contact with the surface of the cavity, and follows all the motions of the sides of the chest. It is distended by the influx of air, when the chest is enlarged; and the air is expelled from the lung, when the chest is diminished. As soon as the thorax is opened in the dead subject, the lung falls down from the sides of the chest, or, in technical language, *collapses*, and then a large empty space is seen between it and the ribs. From this representation it should appear, that the lungs are quite passive in the business of respiration.

The lungs are two in number: one being contained in each bag of the pleura. They are loose and unconnected in these bags, except at one point, towards the upper and posterior portion of each viscus, where the great vessels enter them, and where the bag of the pleura is continuous with the reflected portion of the membrane. These are called the ligaments of the lungs.

Their colour varies considerably. It is always verging more to a red, in proportion as the subject is younger: in the adult, it has more of a spotted and livid cast. Towards the back of the lungs it is always much deeper, from the gravitation of blood in the vessels in consequence of the position of the subject. It is lighter, when the lungs contain much air.

The lungs are subdivided into lobes; of which the right contains three, and the left two. Their substance is composed of a congeries of minute membranous cells, about equal in size to a pin's head, and as these are more or less filled with air, they give the lung a peculiar spongy feel. These cells communicate with the ultimate ramifactions of the air vessels, and receive air from that source. The pulmonary vessels ramify minutely in them, and thereby expose the blood to the effects of the contained air; and in this exposure the object of respiration is effected.

The windpipe. The tube, which conveys the external air into the lungs, may be divided into three parts; the larynx, the trachea, and the bronchi.

The larynx is a hollow cartilaginous organ, placed at the top of the trachea. The air which passes through this from the lungs, in expiration, produces the voice.

The cavity of the larynx opens above at the root of the tongue, and below into the trachea. The organ is composed of five pieces of cartilage: viz. the thyroid and cricoid cartilages and epiglottis, and two arytenoid cartilages.

The thyroid cartilage is the largest, and

consists of two irregularly quadrangular pieces, united in front at an obtuse angle. This part projects in the front of the neck, and much more conspicuously in the male than in the female sex: it is called pomum Adami.

The cricoid cartilage may be compared to a ring with a seal, of which the broad or seal part is placed behind, and the narrower portion in front. It is directly under the thyroid cartilage.

The arytenoid are two pyramidal portions of cartilage, connected by regular moveable articulations to the back of the cricoid.

The epiglottis is the softest cartilage of the larynx. It has a basis firmly tied to the thyroid cartilage, while its opposite extremity, which is very thin, is of a rounded figure, and stands directly upwards, except during deglutition, when it descends so as to cover the opening of the larynx.

The thyroid cartilage is tied by three ligaments to the os hyoides above, and by as many to the cricoid cartilage below; but the most important ligaments of these parts are the ligamenta glottidis; which arise from the front of the arytenoid cartilages, and are attached to the posterior surface of the front portion of the thyroid: A longitudinal slit, called the rima glottidis, is left between these, and it is by the passage of the air through that slit that the voice is formed. Hence, from the great share which these ligaments have in forming the voice, the name of chordæ vocales has been given to them.

The larynx is lined by a vascular and very sensible membrane, copiously moistened with mucus, in order to defend it from the external air. It admits of free motion in the neck, and its parts are also moved on each other; particularly the arytenoid cartilages, whose movements, by altering the size of the ruina glottidis, and the state of tension of the chordæ vocales, contribute most immediately to the variations in the tone of the voice.

The trachea is that portion of the aerial tube, which is placed between the cricoid cartilages and the origin of the bronchi. It is a cylindrical membranous tube, of from 5 to 7-8ths of an inch in diameter. It runs along the middle of the fore-part of the neck, having the large blood-vessels of the head on each side, and being connected behind to the œsophagus. Soon after it has entered the chest, it divides into the two bronchi.

The tube of the trachea is furnished with hoops of cartilage, by which it is kept permanently open for the passage of the air; these are not, however, complete circles, being deficient behind. The lining of the tube is highly vascular and sensible, and covered with a copious mucous secretion, which is rendered necessary by the constant current of air to which it is exposed.

The bronchi are merely the two branches into which the trachea divides for the two lungs; and of these the right is the largest and shortest. They ramify through the lunges dividing into smaller and smaller branches; and the ultimate ramifications communicate with the air-cells.

ORGANS OF CIRCULATION.

The heart is the centre of the circulating system; being the source of the arteries, and the termination of the veins. The younger the subject, the larger is the heart in proportion to the body. It is often smaller in tall and strong men, than under different circumstances.

It is connected at its posterior part, behind the sternum, by the large blood vessels, being unattached every where else, and merely confined in its situation by the pericardium.

The pericardium is placed in the cavity of the chest, behind the second, third, fourth, and fifth ribs of the left side. It is covered to the right and left by the bags of the pleura, which adhere by a loose cellular membrane It is not actually connected by any part of its surface to the sternum. Below, it rests on the diaphragm, and adheres very firmly to the superior surface of the tendon of that muscle.

The cavity of the pericardium is larger than the heart, so that this viscus can move freely in it.

The bag of the pericardium in shape resembles the figure of the heart itself, being conical. Its substance is thick and compact, and it is much more dense and strong than the peritoneum or pleura. Where the great vessels are connected to the heart, this membrane becomes reflected over its surface; and hence the substance of the heart has a close investment from this membrane, besides being contained loosely in the bag-like portion. A small portion of the large blood-vessels is included within the cavity of the pericardium; particularly of the aorta and pulmonary artery; which are consequently covered by the reflected portions.

The internal surface of the pericardi-

um is moistened by a serous secretion from the exhalant arteries; which is collected after death into a few drops of a clear light yellow liquor. It is an unnatural increase of this that constitutes dropsy of the pericardium. This fluid in the living state lubricates the opposed surfaces of the heart and pericardium; and thereby facilitates their motion on each other, and prevents their accretion.

The heart, which is contained almost entirely in the left side of the chest, resembles a half cone; hence we distinguish in it a basis or broad part; and an apex or narrower portion; a convex and a flat surface. The basis is placed towards the right, and backwards; the apex points obliquely to the left, forwards and downwards. The basis is opposite to the seventh or eighth vertebra of the back, and the apex points to the cartilage of the fifth or sixth left rib. The position however varies by the motion of the diaphragm in respiration, as it is drawn down in a strong inspiration, and again rises in expiration. Its position also seems to vary slightly, according to the situation of the body in lying.

A small portion of the left lung seems, as it were, removed just at the apex of the heart; so that that part of the viscus is not covered by the lung like the rest, but touches the front of the chest.

Those cavities of the heart which are called the right are placed in front; and the left cavities are towards the back part; so that the epithets *anterior* and *posterior* would correspond more nearly with the true position of these parts, than those of right and left.

The flat surface of the heart looks directly downwards, and rests on the tendon of the diaphragm; this, therefore, in point of position, is inferior; the convex surface is turned upwards, forwards, and obliquely towards the left, so that it may be called the superior surface.

The weight of the human heart, when removed from the body, with its pericardium, is from 10 to 15 ounces.

Like the heart of all warm-blooded animals, this organ consists of two hearts, closely and intimately connected. One of these is concerned with the circulation through the body, or the greater circulation; the other with the circulation through the lungs, or the minor circulation. These might perform their offices, if separate and even distant from each other. Each of these hearts consists of two cavities; an auricle, or membranous bag, placed at the mouths of the veins; a ventricle, or strong muscular organ, placed at the orifice of the artery, and constructed for the purpose of driving the blood into that vessel and its branches.

The two auricles are placed at the basis or broadest part of the heart; and the two ventricles, composing the chief bulk of the organ, are found in front of the former cavities.

In the following description of the structure of the heart, we shall trace the parts in the same order in which the blood passes through them. This fluid, then, after circulating through the blood-vessels of the body, after serving the various purposes of nutrition, secretion, &c. is returned into the right auricle of the heart by three large veins, *viz.* the superior and inferior vena cava, and the great coronary vein. The properties of this blood have been so altered in its course, that it is necessary for it to be subjected to the action of the atmosphere in the lungs, before it is again fit to be sent into the arteries of the body. The right auricle derives its name of auricle from a small fringed process, which is found at its anterior part; the rest of the cavity is called the sinus of the venæ cavæ. The lining of this bag, as indeed that of all the other parts of the heart, consists of a smooth and polished surface. The muscular fibres of the auricle are not numerous nor large; they are arranged in parallel fasciculi, which have been compared to the teeth of a comb; and hence the epithet of musculs pectinati has been given to them.

The right auricle transmits the blood into the right, anterior, or pulmonary ventricle, through a large circular orifice, called the annulus venosus, or the auricular orifice of the ventricle. When this latter cavity contracts, the blood would be driven back towards the auricle, were not this prevented by a valve, called the tricuspidal or triglochine. This valve is formed by a production of the lining of the heart, divided into three pointed portions. These are tied by tendinous strings to certain projecting packets of the muscular fibres, called the fleshy columns of the ventricle. The structure of the ventricle is very different from that of the auricle. It is a strong muscular cavity, adapted to the office of forcibly projecting the blood through the arterial ramifications; whereas the auricle is a mere reservoir, holding the blood until the ventrical has emptied itself by its contraction.

The pulmonary artery, which arises from the upper and anterior part of this ventricle, conveys the blood into the lungs. The opening of this artery, which is called the arterial orifice of the ventricle. is furnished with three valves, called sigmoid or semilunar, which prevent any retrograde motion of the blood from the artery towards the heart.

The venous blood, by being exposed to the atmospheric air in the lungs, is altered in its properties, and becomes arterial blood, in which state it is returned to the left auricle of the heart by four pulmonary veins, two of which belong to each lung. This left or posterior auricle consists of a large cavity, called the sinus of the pulmonary veins; and of a smaller process or auricula. It is situated quite at the upper and back part of the heart, and transmits the blood through the auricular orifice of the left ventricle into that cavity. This opening is perfectly similar in all essential circumstances to the corresponding part on the right side of the heart. But its valve, being divided into two portions only, is called mitralis, from a comparison with a bishop's mitre.

The left ventricle is much thicker and stronger than the right. It feels externally almost like a solid mass of flesh; while the right is comparatively thin and flabby. The reason of this difference is obvious. The left ventricle has to drive the blood to the most remote parts of the body, whereas the right only sends it through the lungs. The aorta arises from the left ventricle, and its mouth is guarded by three semilunar valves. This is the trunk from which the arteries of the whole body arise.

STRUCTURE OF THE ARTERIES.

Those vessels, through which the blood flows from the heart into every part of the body, are called *arteries*. The term, which is derived from αηρ, air, and τηρεω, I hold, was first adopted by the anatomists of the Alexandrian school, in consequence of the erroneous opinion which they entertained, that these vessels were designed for the distribution of air throughout the body.

The larger arteries have thick and elastic sides, so that they remain open when divided, and present a regularly circular aperture. The sides may be separated into three strata of dissimilar substances, which are technically called coats. The innermost, which is generally termed the cuticular coat, is thin, strong, and highly elastic. The internal surface of this coat is perfectly smooth, so that the blood glides along it without impediment; the external surface is connected to that coat which surrounds it. The middle, or, as it is called, the muscular coat, is composed of a congeries of circular fibres, separable into numerous strata, but not much resembling muscular fibres as found in other situations. The external coat of the artery is made of condensed cellular substance, which unites these vessels to the neighbouring parts.

It appears that the larger vessels have the greatest elastic power, with the smallest muscular force; while these properties exist in reversed proportions in the smaller vessels. In the large arteries muscular power is unnecessary, for the force of the heart is fully adequate to the propulsion of the blood; but in the smaller arteries, where the effect of the heart's action declines, a proportionate muscular power is allotted to the vessels, to urge on the circulating fluids.

The arteries have their nutrient arteries and veins, their absorbents, and their nerves.

All the arteries proceed from one great vessel, as the branches spring from the trunk of a tree; and we proceed to notice certain circumstances observable in their ramifications.

1. When an artery gives off a branch, the conjoined areas of the two vessels make a greater space for the blood to move in, than the area of the original vessel. The increase of dimensions in the branches of a large artery is slight; but in those of a small one it is so considerable, that Haller has estimated it as surpassing by one third that of the trunk from which they sprung. The conjoined areas of all the small arteries so greatly exceed that of the aorta, that the same anatomist, in opposition to former opinions, affirms that these vessels are conical, the basis of the cone being in the extreme arteries, and the apex in the heart.

2. When a large artery sends off a branch, its course does not, in general, deviate further from that of the trunk than an angle of 45 degrees. Sometimes a branch, which has gone off at an acute angle, returns, and proceeds in a contrary direction to that of the trunk. Sometimes indeed a large artery does proceed from the trunk at nearly a right angle, as the renal arteries. Though the large arteries generally ramify at acute angles, there is great diversity in the branching of the smaller ones.

3. Arteries in general do not pursue a straight, but a serpentine course; this is remarkably the case in some instances; as in the spermatics, those of the face and occiput, and in most of the smaller arteries.

4. Though the ramification of arteries may be compared to the branching of trees, yet it differs materially in this particular, that the different branches frequently conjoin. This conjunction is technically termed, if we borrow the term from the Greek language, their *anastomosis;* if from the Latin, their *inosculation.* This union of arteries rarely happens among the larger ones, but frequently among the smaller; and increases in number in proportion to the minuteness of the vessels. The utility of the inosculations of arteries is evident; were it not for this circumstance, if any arterial trunk were accidentally compressed, so that the current of blood in it should be for some time obstructed, the parts which it supplied must perish. But in consequence of the frequent communications of these tubes with each other, the blood can pass from the adjacent arteries into all the branches of any one accidentally obstructed.

When arteries inosculate, two currents of blood, moving in opposite directions, must come together, and retard each other's motion. This probably is the reason, why larger arteries, in which the blood flows with rapidity, so seldom conjoin; whilst the smaller ones, in which the blood's motion is more tardy, communicate in surprising numbers, and with a frequency proportionate to their minuteness. The very frequent communications of the minute arteries prevent the prejudicial consequences of obstruction of the trunks almost as effectually, as if those arteries themselves communicated by more direct and larger channels.

All these minute arterial tubes are capable of enlargement; and it is an ascertained fact, that even the aorta itself may be gradually obstructed at some distance from the heart, without the parts which it supplies being deprived of nourishment. From an attentive consideration of all these circumstances, it has been concluded, that the moderate increase of the area of the branches of large arteries; the acute angles at which they divide; their nearly rectilinear course; and the rare occurrence of inosculation between them; are designed to facilitate the rapid motion of the blood in them, so that it may arrive unchanged, and in the same state that it was in when projected from the heart, at that part of the body, for the nourishment of which it was intended: whilst, on the contrary, the great increase of the area of the smaller vessels, the variety of their angles, their tortuous course, and their frequent communications, were designed to check the velocity of the blood's motion, when it has arrived at that part, where secretion is to be performed, and nutrition is to take place. Contrary opinions have indeed been maintained; and for the further discussion of this subject, we must refer the reader to the remarks on the *circulation* in the article PHYSIOLOGY.

Termination of the arteries.—When these vessels have become very minute, they terminate in two ways: they either turn back again, and become veins, and return the blood to the heart, or they send off fine vessels, which abstract something from the circulating blood, and are therefore called secerning arteries. Though none but minute arteries are ever reflected to become veins, yet many of them are of sufficient magnitude to admit common waxen injection; and when this experiment succeeds, the continuity of the arteries and veins is very manifest. It seems therefore to follow from this facility of communication, that the mass of the blood is constantly and freely circulating, in order to undergo that change which is effected in the lungs, whilst but a small part of it proceeds into the very minute arteries, for the purpose of having secretions made from it. For these arteries, however minute, must be considered large, in comparison with the exility of others, which cannot be injected with wax, and even reject the red globules of the blood, or admit them in such small proportion, that they do not impart the red colour to the fluid which moves in those vessels. Now, we may venture to affirm that these globules do not much exceed in diameter the 150,000th part of an inch, which circumstance sufficiently shows the minuteness of the lesser arteries.

The secerning arteries are in general too minute to admit of demonstration; they are however evident in some glands; in the kidney, for instance, they may be seen continued into the excretory vessels. Subtile injections, when thrown into the larger arterial trunks, ooze out on the surfaces of membranes, and into the cellular substance, and they are generally supposed to be poured forth from the open orifices of secerning arteries. Analogy, therefore, rather than actual demonstration, leads us to believe, that the secerning arteries abstract the particles of nutrition, or the materials which compose the fabric of the body, from the circulating fluids, and de-

posit them from their open mouths, so as by this means to build up and keep in repair the structure of the body.

Distribution of the arteries.—The great artery, whose branches supply the whole of the body, is named the *aorta*. It arises from the upper part of the left ventricle; and emerges from the heart, between the pulmonary artery and the right auricle. It first ascends in the chest; opposite the upper edge of the second rib it bends backwards till it reaches the left side of the spine, in which situation it descends from the fourth or fifth dorsal to the last lumbar vertebra.

By the arch of the aorta is meant that part of the vessel which arises from the heart, and bends across the chest. It sends off the following branches: the two first arising at right angles close to the heart; the three following from the convexity of the arch:

1. Right coronary artery of the heart.
2. Left coronary artery of the heart.
3. Arteria innominata, a common trunk, dividing into
   1. Right subclavian.
   2. Right common carotid.
   3. } Left common carotid.
   4. } Left subclavian.

The common carotid artery is destined for the supply of the head. It emerges from the chest by the side of the trachea: mounts upwards in front of the vertebræ, and parallel with the trachea, till it reaches the upper margin of the thyroid cartilage, without sending off a single branch. At this part it divides into the external and internal carotid arteries, the former of which is distributed to the outside of the head; the latter to the brain.

The external carotid continues its course upwards between the jaw and the ear, being imbedded in the substance of the parotid gland.

Branches of the external carotid artery.

1. Superior thyroideal.
   - *a.* Laryngeal branch.
2. Lingual artery.
   - *a.* Hyoideal branch.
   - *b.* Artery to the back of the tongue.
   - *c.* Raminal artery.
3. Facial or labial, or external maxillary.
   - *a.* Ascending palatine branch.
   - *b.* Arteries to the surrounding glands.
   - *c.* Inferior labial artery.
   - *d.* Coronary artery of the lower lip.
   - *e.* Coronary artery of the upper lip.
   - *f.* Nasal arteries.
4. Ascending pharyngeal artery.
5. Occipital artery.
6. Posterior artery of the ear.
7. Superficial temporal artery.
   - *a.* Branches to the parotid gland.
   - *b.* Anterior auricular arteries.
   - *c.* Transverse artery of the face.
   - *d.* Middle temporal artery.
   - *e.* Anterior temporal branch.
   - *f.* Posterior temporal branch.
8. Internal maxillary artery.
   - *a.* Middle artery of the dura mater, or spinous artery.
   - *b.* Inferior maxillary artery.
   - *c.* Pterygoid branches.
   - *d.* Deep temporal branches.
   - *e.* Artery of the cheek.
   - *f.* Alveolar artery of the upper jaw.
   - *g.* Infra-orbital artery.
   - *h.* Superior palatine branch.
   - *i.* Nasal branch.

The internal carotid artery enters into the skull, through the canal formed in the substance of the temporal bone. And its branches ramify through the substance of the brain. All the arteries of the brain have thinner coats than these vessels possess in any other part of the body.

Branches of the internal carotid artery.

1. Ophthalmic artery, supplying all the parts contained in the orbit.
   - *a.* Lacrymal branch.
   - *b.* Ethmoidal arteries.
   - *c.* Superior and inferior muscular branches.
   - *d.* Central artery of the retina.
   - *e.* Ciliary arteries.
   - *f.* Superior and inferior palpebral branches.
   - *g.* Nasal artery.
   - *h.* Frontal artery.
2. Communicating branch.
3. Anterior artery of the brain.
4. Middle artery of the brain.

The subclavian artery passes over the first rib, and behind the clavicle, into the cavity of the axilla. There it takes the name of *axillary*, and is covered by the pectoral muscles. Emerging from the armpit, its name is again changed for that of *brachial*. This part of the trunk runs along the inside of the arm, close to the edge of the biceps muscle, until it reaches the elbow joint, where it divides into the branches that belong to the fore arm.

Branches of the subclavian artery.

1. Internal mammary.

2. Inferior thyroideal.
   a. Thyroid branch.
   b. Ascending thyroid artery.
   c. Transverse artery of the neck.
   d. Transverse artery of the shoulder, or supra scapulary.

3. Vertebral, a large trunk passing through perforations in the transverse processes of the cervical vertebræ, and through the foramen magnum of the skull to the brain, where it unites with its fellow of the opposite side, to form the basilar artery.
   a. Inferior artery of the cerebellum.
   b. Arteries to the spinal marrow.
   c. Superior artery of the cerebellum.
   d. Posterior or deep seated artery of the brain.

N. B. The arterial circle of Willis is a large anastomosis; by which the two carotids are joined together, and united also to the basilar artery.

4. Superior intercostal.
5. Deep-seated cervical artery.
6. Superficial cervical artery.

Branches of the axillary artery.

1. Superior or short thoracic.
2. Inferior or long thoracic.
3. Thoracic artery of the shoulder.
4. Deep thoracic artery.
5. Infra-scapular artery.
6. Posterior circumflex.
7. Anterior circumflex.

Branches of the brachial artery.

1. Various muscular branches.
2. Profunda humeri major, or greater deep-seated artery of the arm.
3. Medullary artery of the humerus.
4. Lesser deep-seated artery of the arm.
5. Great anastomizing branch.
6. Radial artery.
7. Ulnar artery.

The two last branches are those into which the trunk of the brachial divides at the elbow. They run along the fore-arm to the wrist.

Branches of the radial artery.

1. Recurrent branch.
2. Superficial artery of the palm.
3. Branch to the back of the wrist.
4. Branches to the back of the thumb and fore-finger.

The artery then enters the palm, and forms the deep-seated arterial arch of the palm.

Branches of the ulnar artery.

This vessel, when it has arrived at the wrist, passes forwards into the palm of the hand, more superficially than the radial, and forms the superficial arch of the palm.

1. Recurrent artery.
2. Interosseous artery.
   a. Posterior branch.
      α. Interosseous recurrent.
   b. Anterior branch.
3. Branch to the back of the hand.
4. Deep palmar branch.
5. Three large digital arteries.

Branches of the descending portion of the aorta in the chest.

1. Common bronchial artery.
2. Right and left bronchial arteries.
3. Esophageal arteries.
4. Lower intercostal arteries.

The aorta passes through the diaphragm at the lower part of the chest, and takes the name of abdominal aorta. It is still situated on the left side of the bodies of the vertebræ, and at the fourth lumbar vertebra it terminates by dividing into the two common iliac trunks.

Branches of the abdominal aorta.

1. Right and left phrenic arteries.
2. Cœliac artery.
   a. Coronary artery of the stomach.
   b. Hepatic artery.
      α Duodeno-gastric, or gastro-epiploic artery.
      β Superior pyloric artery.
      γ Cystic artery.
   c. Splenic artery.
      α Pancreatic arteries.
      β Short arteries to the stomach.
      γ. Left gastro-epiploic artery.
3. Superior mesenteric artery.
   a. From 12 to 20 large branches to the small intestine.
   b. Middle colic artery.
   c. Ileocolic artery.
4. Renal or emulgent arteries.
5. Spermatic arteries.
6. Inferior mesenteric artery.
   a. Left colic branch.
   b. Internal hemorrhoidal branch.
7. Five pairs of lumbar arteries.
8. Two common iliac arteries.
9. Middle sacral artery.

The common iliac quickly divides into the external and internal iliac branches, of which the former goes to the thigh, the latter enters the cavity of the pelvis,

Branches of the internal iliac artery.

1. Ileo-lumbar artery.
2. Lateral sacral arteries.
3. Vesical arteries.
4. Middle hemoirrhoidal.
5. Uterine branch.
6. Obturator artery.
7. Gluteal artery.
8. Ischiatic artery.
9. Pudendal artery.
   - *a.* External hemorrhoidal branches.
   - *b.* Artery of the perineum.
   - *c.* Dorsal artery of the penis.
   - *d.* Deep artery of the penis.

The external iliac artery having changed its name for that of femoral, runs along the front of the thigh, and then bends inwards to the ham, where it takes the name of popliteal. It passes through the latter space to the leg, when it terminates by dividing into two, of which one runs along the front, and the other the back of the leg.

Branches of the external iliac artery.

1. Epigastric artery.
2. Circumflex artery of the ilium.

Branches of the femoral artery.

1. Branches to the lymphatic glands, and integuments.
2. External pudic arteries.
3. Deep-seated artery of the thigh.
   - *a.* External circumflex artery.
   - *b.* Internal circumflex artery.
   - *c.* First and second perforating branches.
4. Branches to the neighbouring muscles.
5. Great anastomosing branch.

Branches of the popliteal artery.

1. Superior internal articular artery.
2. Superior external articular artery.
3. Middle articular artery.
4. Inferior internal articular artery.
5. Inferior external articular artery.
6. Anterior tibial artery.
7. Posterior tibial artery.

Branches of the anterior tibial artery.

1. Recurrent branch.
2. Various small muscular branches.
3. External and internal malleolar arteries.
4. Tarsal and metatarsal arteries.
5. Dorsalis hallicis.

Branches of the posterior tibial artery.

1. Large muscular branches to the soleus.
2. Medullary artery of the tibia.
3. Peroneal or fibular artery.
   - *a.* Anterior branch.
   - *b.* Posterior branch.
4. External plantar artery.
   - *a.* Four digital arteries.
5. Internal plantar artery.

There is another large arterial trunk in the body, besides the aorta, called the pulmonary artery; this rises from the right ventricle, and conveys the venous blood to the lungs, for the purposes of respiration.

OF THE VEINS.

The blood is constantly moving in the arteries from the trunks into the branches; in the veins it follows a directly opposite course, and flows from the branches to the trunks.

There are seven large venous trunks in the body, to which all the blood is returned; three of these, *viz.* the superior and inferior vena cava, and the coronary vein of the heart, return the blood, which has circulated through the body into the right auricle of the heart; the other four are the pulmonary veins, and bring the blood back from the lungs to the left auricle.

The coats of the veins are thin when compared with those of the arteries; hence the blood can generally be plainly seen through them; and hence when divided they collapse, instead of presenting a circular section, as arteries do. It is difficult to separate them into coats, yet they are said to consist of two; *viz.* a smooth and highly polished internal one, which lines the canal; and a rough, cellular external tunic, in which no muscular power resides. Hence the circulation proceeds through these vessels merely by the impulse of the arterial blood, and is not aided by any action of the containing tubes.

The veins are much more numerous, and also larger than the arteries. In most parts of the body each artery has two veins lying by its side; and in many instances there is another numerous set of veins besides these. Hence the venous system is much more capacious than the arterial; and this difference is so great, that the veins are supposed to contain nine parts out of thirteen of the whole mass of blood. This great capacity of the venous system obviates the effects of any

casual obstruction to the ready transmission of blood through the lungs; for the whole of the veins are not distended in a natural state, but serve as an occasional reservoir, in which the blood, constantly urged forwards by the heart, may be held till the cause of obstruction has ceased. But as such retardation in the course of the venous blood would tend to drive back the whole mass on the minute veins, which are the least able to bear it, such retrograde motion is prevented by valves, which exist in great numbers in the venous system. These are thin membranes, having a semilunar edge attached to the side of the vein, and a straight edge floating in the cavity of the vessel: they are placed in pairs. When the blood is going on in its natural direction, they lie close to the sides of the tube; but, when it attempts to return, the blood raises the loose edge, and that meets in the centre of the vessel with the corresponding part of the opposite valve, and thus closes the canal. Thus, when an obstruction takes place, each portion of a vein has to support that column of blood only which is contained between its own valves. Still, as these vessels possess no powers of their own, and are too far removed from the heart to feel its influence on the passage of blood through them, we find that the circulation is affected in them by external causes, as position, &c. Hence the legs swell after long standing; and hence also the veins of these parts are apt to become enlarged and varicose.

Distribution of the veins.—This is for the most part similar to that of the arteries, as each of the latter vessels have generally two accompanying veins, (which bear the same names as the concomitant arteries) named venæ sodales arteriarum. But in some situations there is a class of veins not corresponding to the arteries, but running under the skin, and termed cutaneous or superficial veins. These are found particularly in the extremities, and vary much in size at different times.

The vena cava superior is formed by three large trunks.

1. Vena azygos, which returns the blood from the sides of the chest, and runs along the middle of the spine.

2. Right subclavian, which is also made up by three venous trunks, *viz.* the internal jugular, the external jugular, and the axillary.

3. Left subclavian, formed in the same manner as the right.

The external jugular vein returns the blood from the outside of the head, and runs along the neck, just under the skin. We sometimes bleed from this in affections of the head.

The internal jugular is a very large vessel, lying deeper in the neck, and close to the carotid artery. It brings back the blood from the brain. The danger in attempts at suicide consists in dividing this vessel or the carotid artery, and not the external jugular vein. The axillary vein is made up of the vessels which bring the blood back from the arm. Besides the deep-seated veins, we have here a large superficial vessel, running along the outside of the fore-arm and arm, and called the cephalic vein; another on the inside, named the basilic. Between these in the fore-arm are found some veins called the median. At the bend of the elbow these last make up two large trunks, of which one opens into the basilic, and the other into the cephalic vein. These are called vena mediana basilica, and vena mediana cephalica. It is the latter veins that we generally bleed, when that operation is performed in the arm; and as they run directly over the artery, the latter vessel is endangered by the lancet.

The inferior vena cava is a very large trunk, running along the spine at the right side of the aorta. It returns the blood from all the lower parts of the body. It is made up by the junction of the two common iliac veins; and as it ascends through the abdomen, it receives the following venous trunks; the lumbar, spermatic, renal, and the immense venæ cavæ hepaticæ.

The common iliac vein is formed by the junction of the external and internal iliacs. The latter brings back the blood from the cavity of the pelvis; the former returns it from the lower extremity.

We have two large cutaneous veins to notice in the leg and thigh; viz. the saphena major, which runs up along the inner side both of the leg and thigh, and can be distinctly seen in the living person when in the erect posture; the saphena minor, which runs over the calf of the leg. The former terminates in the femoral vein near the abdomen, the latter in the popliteal vein.

The vena portarum is a large vessel, formed by the union of those veins which belong to the stomach and intestines, the spleen and pancreas. It conveys the blood, which has circulated through those organs to the liver, and it branches out in that gland as arteries do in other parts. Its blood is returned from the liver by the hepatic veins, which have been already noticed.

ORGANS OF ABSORPTION.

The absorbents are a minute kind of vessels found in animal bodies, which attract and imbibe any fluid that is brought near their mouths. They are so minute and transparent, as not to be discovered in ordinary dissection; but by great labour they have at length been detected in great numbers in every tribe of animals. As these vessels are transparent, their contents are visible, which circumstance occasioned them to receive the different denominations of lacteals and lymphatics. The former were so called, because they imbibed the chyle, a milky fluid, from the bowels; whilst the latter, containing much lymph, which they had taken up from all the interstices of the body, were therefore named lymphatics. The discovery of this system of vessels is referred to the seventeenth century. But at first their number did not appear sufficient to perform the whole function of absorption; neither had they been discovered in birds or fishes, whence anatomists still retained the idea that the veins participated in this important office. The merit of first demonstrating the absorbing vessels in those animals belongs to Mr Hewson, who assisted in the labours of the first eminent anatomical school in London, where anatomy was most ably taught by Dr. Hunter. And it is to the immortal Hunter that we are indebted for fully proving the important doctrine, that the whole business of absorption is performed by the vessels which we are now considering. They have of late been injected in such great abundance, that they appear fully adequate to perform their office.

If, as we firmly believe, these vessels be the only ones which perform the office of absorption, they must exist in every part of the body. For there is no spot on the surface of the skin from which ointment may not be taken up, nor any internal part from which blood, when accidentally effused, may not be absorbed; nay, the very matter composing the texture of our bodies is undergoing continual removal and renovation. These vessels must therefore be supposed to begin by open orifices generally throughout the body, although the fact can be demonstrated in the intestines only. On the inner surfaces of these organs they appear to the unaided eye fine and pointed tubes: but by the microscope their mouths are discerned to be patulous, and like a cup. The beginning absorbents soon join together, and after some time form minute vessels, capable of being injected by anatomists: these again conjoin, and form larger vessels, which are still discoverable with great difficulty.

In structure and arrangements these vessels have great similitude to veins: they have in consequence been named by some anatomists the lymphatic veins. Like the veins, their sides are thin and transparent, though of considerable strength: like the veins, they frequently communicate together, or, as it is technically termed, anastomose. The advantage derived from these communications is obvious: for by these means, the dissimilar matters which they take up from various parts are mixed together, and blended with the lymph, which they imbibe from the interstices of the body, and which serves as the vehicle for such heterogeneous particles; they also prevent accidental pressure made on a few vessels from obstructing the progress of the absorbed fluids, which are in that case conveyed forwards by collateral channels. Like the veins also, these tubes, by conjoining, form a tube of smaller area than the united areas of the vessels before their junction. The effect of this construction is the same as in the veins; that is, an acceleration in the current of the lymph, in proportion as it comes nearer to the trunk of the absorbing vessels. The diameter of the thoracic duct bears but a small proportion to the united diameters of all the minute absorbents in the body, and when this duct has been opened, the lymph has flowed from it with a force and jet like that with which the blood issues from a large vein. Like the veins, the absorbents are furnished with numerous valves, which prevent any retrograde motion of their fluids, and also prevent any portion of the vessel from sustaining the weight of more fluid than is contained between its valves. The absorbents, however, differ from the veins in one very material circumstance, *viz.* that they have a power of contraction, and are able of themselves to propel their contents. Whoever reflects on the phenomena of absorption can scarcely doubt that these vessels have a contractile power, by which they refuse admission to noxious substances, whilst they readily imbibe those that are salutary. If these vessels are observed in the mesentery, when turgid with absorbed chyle, their contents will disappear in a certain tract, and again become visible; a phenomenon that can only be explained by supposing the vessel to contract at that part, and urge forwards its contents. Haller found that the thoracic duct contracted when stimulated, so that there can be little

doubt of these vessels being muscular throughout their whole extent.

The absorbents are found in considerable numbers under the skin of the extremities; and when they arrive at the groin and armpit, they pass through little bodies about the size of small beans, which are called lymphatic glands. The absorbent vessels, as they approach the gland, generally separate into several branches, which terminate in that body: and again, about an equal number of absorbents emerge from the gland, conjoin, and form one or more principal absorbing vessels. The absorbents, which enter the gland, are usually denominated vasa inferentia, and those which go out of it, vasa efferentia. If quicksilver be poured into the former vessels, the gland swells, and a great deal of quicksilver appears to be deposited in it; and afterwards, if the power propelling the injection be continued, it is seen coming out of the gland by the vasa efferentia. It seems therefore to follow, that the progress of the absorbed fluid is checked a little in these glands, and it is probable, that some change is effected in its progress through them. This opinion is confirmed by observing, that these glands abound with blood-vessels, which probably pour some fresh animal juices into those which are contained in the lymphatic vessels.

The lymphatic glands are found in great numbers in the groin, armpit, and side of the neck, apparently serving like barriers to the absorbents of the head and extremities, as they approach to the large veins of the trunk. The absorbents of the intestines, which contain the chyle, a scarcely animalized fluid, sometimes pass through three or four sets of glands, before they arrive at the thoracic duct; hence they are called lacteal vessels primi, secundi, tertii, or quarti generis. The place where the lacteals conjoin, and meet with the lymphatics from the lower parts of the body, to form the thoracic duct, appears in animals like a reservoir, and has been named the receptaculum chyli. The vessel thus formed, penetrates the diaphragm, in conjunction with the aorta, and is called the thoracic duct. In this situation it lies close on the back bone, between the vena azygos and the aorta. Towards the neck, it leaves the bone to reach the left subclavian vein, into which its contents are poured; the absorbents of the left arm and side of the head having previously joined it. The passage of blood from the vein into the duct is effectually precluded by means of valves.

The absorbents of the right arm and side of the head form a smaller trunk on the right side, which opens into the corresponding part of the right subclavian vein.

Thus, all the old materials of the body, which the absorbents are continually removing, all the new matter imbibed from the surface, all the redundant lymph taken up from the interstices of the body, and all the chyle occasionally obtained from the bowels, are conveyed into the large veins near the heart. It is, in short, chiefly by this system of vessels, that the blood is augmented in quantity, or altered in quality; they replenish the body with nutriment, and occasionally taint it with infection.

It is sufficient to inform the reader, that these vessels exist in great numbers in all parts of the body, without entering into any detailed description of their particular distribution. We may just observe, that the course of these vessels, and their entrance into glands, become occasionally demonstrated in disease. When irritated by any local mischief, they form red streaks, manifest on the surface of the body; and the irritating or poisonous nature of the matters which they imbibe causes swelling and inflammation of the glands in which this matter is deposited. Thus the glands in the groin swell from the absorption of venereal matter; those in the axilla become affected in cancer, and in the inoculation for the small pox.

OF THE URINARY ORGANS.

The urine is secreted in two large glands, called the kidnies. These are situated behind the peritoneum, in that part of the abdomen termed the lumbar region, where they are surrounded by a quantity of loose cellular and adipous substance. Their form resembles pretty exactly that of the kidney bean. There seems to be a small part as it were scooped out, opposite to the bodies of the vertebræ; at this, which is called the notch of the kidney, the blood-vessels enter.

When we make a cut through the substance of this organ, it is found to be made up of two substances, differing in appearance. The exterior is called the cortical or arterial part, the interior, which consists of several conical portions, is named the uriniferous. The latter remains perfectly white, if a kidney be injected.

Several very minute converging tubes are seen running through the uriniferous portion, and terminating by open mouths on their conical points; these, which can be filled with minute injection from the arteries, and the open mouths of which can be seen with the aid of a small magnifying power, are the excretory tubes, or tubuli uriniferi, of the kidney. The uriniferous portion of the gland forms about fifteen conical projections, termed papillæ; on each side of which the excretory tubes open in great numbers. The papillæ project into short membranous canals, called infundibula; and these terminate in a common receptacle, situated at the notch of the kidney, and known by the name of the pelvis. From this, a canal about equal in size to a writing quill, the ureter, conveys the secreted fluid into the bladder.

The bladder is a membranous and muscular reservoir, receiving the urine as it is found in the kidnies, retaining it until it has accumulated in some quantity, and then expelling it through a canal called the urethra.

The internal surface of the bladder is formed by a smooth membrane, constantly covered with a mucous secretion, which defends it from the irritating effects of the contained fluid. It has a muscular coat, sometimes described as a muscle, under the name of detrusor urinæ; and that part of the fibres, which is situated round the opening of the urethra, is called the sphincter vesicæ, as it keeps the aperture constantly closed, until we make an effort for the expulsion of the contained fluid. The ureters open into the lower part of the bladder; and open in such a manner, that, although the urine flows readily from them into the receptacle, none can return. They pass between the muscular and internal tunics, before they penetrate the latter.

The bladder is situated just behind the ossa pubis; and is partly covered by the peritoneum. The urethra proceeds from its lower and anterior surface, and this part is called the neck of the bladder; it then goes under the arch of the pubis. It forms in the female a canal about an inch and a half, or two inches long, which opens in the cavity left between the labia pudendi. In the male it is about nine inches in length, and runs along the under part of the penis to the extremity of that organ, where it opens.

ORGANS OF GENERATION.

The parts which the two sexes perform, in the important business of propagating the species, are so entirely different, that we shall not be surprised at finding that the male and female organs of generation are wholly dissimilar to each other.

The germs or rudiments of the future beings are produced by the female, in organs called the ovaria. But these remain inert and useless, unless called into action by the fecundating influence of the male. The fecundating fluid is prepared in two glands, called the testes. When the germ has been acted on by this fluid, it passes through a canal called the fallopian tube, into the uterus, where it is retained until it has acquired a considerable magnitude; and from which it is expelled at the end of nine months. The seminal liquor of the male is poured into the urethra, and is introduced by means of the penis into a membranous cavity of the female, called the vagina.

External parts of generation in the female. Over the surface of the pubis, there is a greater accumulation of fat and cellular substance than in the male; and the prominence caused by this structure is called mons veneris. A longitudinal cavity extends from this eminence in front to the anus behind; and the sides of it are bounded by two folds of the skin, called labia pudendi, or alæ majores. The whole of these parts taken together constitute the pudendum, or sinus pudoris. The mons veneris, and the outer surface of the labia, are covered with hair to a greater or less extent.

The parts contained within this longitudinal cavity are covered by a more delicate kind of integuments, than that which composes the general surface of the body. A change takes place in the organization of the skin, somewhat similar to that which is observed at the lips. Hence the surface of the parts contained within the labia has a red, smooth, and soft covering; which is besmeared with a cebaceous secretion of peculiar odour, furnished by numerous small glands, lying just under the surface. This unctuous matter is required in order to defend the parts from the urine; and also to obviate the effects of that rubbing on each other, which must be occasioned by the motions of the body.

Towards the upper part of the longitudinal slit, left between the labia, a small prominent organ is discerned, called the clitoris. This exactly resembles the male penis in structure. It only projects, however, about a quarter of an

inch. We distinguish in it a glans and preputium, which resemble, on a small scale, the parts of the same name in the male.

Below the clitoris are two small folds, called the nymphæ. These are connected above to the preputium clitoridis; they diverge from each other, as they extend below. They vary much in size; in a natural state they may measure about half an inch at the broadest part. They are of a much greater magnitude in the Hottentot female, and have given rise to the reports of travellers, that the sinus pudoris is covered in those persons by a curtain, or apron of skin. About three quarters of an inch below the clitoris, we meet with a round aperture, which is the termination of the female urethra: and just below this is the opening of the vagina; which opening is technically called os externum uteri. This has a very different appearance in a young girl, and in a married woman. In the latter it is a large and free aperture, fully adequate in size to the admission of the penis; in the former it is shut up in a great measure by a thin membrane, called the hymen. This closes the lower portion of the os externum, to various extents in different subjects; and is torn and destroyed by the consummation of marriage. Some little excrescences, supposed to be the remains of the ruptured hymen, are called carunculæ myrtiformes. The anus is found about one inch behind the commencement of the vagina.

The vagina, or canalis uteri, is a membranous canal, about five inches in length, extending almost directly backwards from the os externum. Its sides are dense and tough; and the surface is covered with numerous wrinkles and prominences, which are less conspicuous in women who have had children than in virgins.

The uterus is a hollow organ; but its cavity is so small in the impregnated state, and its sides are so thick and dense, that it feels like a solid fleshy mass. Its broadest and largest part, which is called the fundus, is situated directly upwards. The smaller and narrower portion, termed the neck, is downwards. The length of the organ, from the fundus to the end of the neck, is about three inches; its breadth at the fundus about one inch, and at the cervix considerably less. It is situated within the cavity included by the bones of the pelvis. The peritoneum passes from the bladder to the anterior surface of the uterus, and completely covers the organ. It is extended from the two sides of the uterus to the bones of the pelvis, forming two broad duplicatures, called the broad ligaments of the uterus; each of which includes three parts, named the appendages of the uterus: *viz.* the ovarium, fallopian tube, and round ligament.

The cavity of the uterus opens into the posterior part of the vagina by an orifice, named the os tincæ or os internum uteri.

The round ligament of the uterus is a fibrous chord, passing from the fundus uteri through the abdominal ring, and serving to confine this organ in its proper situation.

The ovarium is an oval fleshy body, situated towards the posterior surface of the broad ligament. It contains some small watery vesicles, called ovula graafiana, which are supposed to be the germs of the future beings, that are to be called into action by the stimulus of the male semen.

The fallopian tube is a convoluted canal, commencing by a very minute orifice from the corner of the uterus, running along the upper margin of the broad ligaments, and gradually increasing in size, till it ends near the ovarium by a broad trumpet-shaped mouth, open to the cavity of the abdomen, and having an elegant arrangement of plaits and fringes surrounding the aperture, whence it is often called the fimbriated extremity of the tube.

Male organs of generation.—The testes, or glands, which produce the semen, are contained in the scrotum, a bag formed of common integuments, and hanging from the front of the pelvis between the thighs. A prominent line, called the raphe, runs along the middle of this, and divides it into two equal portions. The testes are surrounded and connected in their situation by a loose cellular substance. They are of an oval shape, and about equal in size to a pigeon's egg. They hang from the abdomen by the spermatic chords, which consist of the arteries, veins, lymphatics, and excretory tubes of the testes, united by a cellular substance, and covered by a muscle, called the cremaster, by the action of which the testis is occasionally drawn up towards the belly.

The substance of the testis is covered by two membranous tunics, one, which immediately invests it, and is called tunica albuginea; another, which surrounds this more closely, and forms a bag, in which the testis hangs, the tunica vaginalis.

There is a small body partly distinct from the testis, and placed behind it, called the epididymis.

The substance of the testis is found by dissection to be soft; and it is composed of a congeries of very minute tubes, named tubuli seminiferi, which may be unravelled and separated by macerating in water, although they were previously connected into the appearance of a fleshy mass. The diameter of these tubes is estimated at 1-200th of an inch; and the number of them at about 60,000. If they were joined together, they would form a tube of about 5000 feet long. These tubes terminate ultimately in a single small canal, which, by its innumerable turns and windings, makes up the whole epididymis. If this could be completely drawn out, it would be about 30 feet long. It increases rather in size towards the end of the epididymis, and leaves that body in the form of a simple and unconvoluted tube, assuming the name of vas deferens, and ascending along the back of the spermatic chord to the abdomen. It can be readily distinguished in that situation in the living person: it feels like a hard chord, about the size of a crow quill.

When the spermatic chord has entered the abdomen, the vas deferens leaves it, runs along the back of the bladder, and opens into the commencement of the urethra.

Vesiculæ seminales.—Before the vas deferens terminates in the urethra, it is joined at an acute angle by the canal of the vesicula seminalis.

These vesicles are two soft bodies, lying in contact with the under-surface of the bladder, and formed, each of them, by the convolutions of a single membranous tube. An injected liquor thrown into the vas deferens will pass into the vesicula seminalis, rather than into the urethra; for the opening into that canal is extremely small, while the communication with the vesicula is large and free. Hence it has been suppossd that these vesicles are reservoirs for retaining the fluid formed in the testicles until it is wanted.

Mr. John Hunter has however pretty clearly demonstrated that the vesiculæ are not intended to contain semen, but that they secrete a peculiar fluid, to subserve the purpose of generation. See his "Observations on certain parts of the Animal Economy."

Prostate gland.—The origin of the urethra is surrounded by the substance of this gland, which in size and form much resembles the chesnut. Numerous openings are found in the commencement of the urethra, which discharge on pressure a whitish viscid fluid, secreted in the subsubstance of the prostate. A portion of the gland projects into the lower part of the commencement of the urethra, and has received the name of caput gallinaginis: it is on this that the openings of the canals, formed by the junction of the vasa deferentia and vesiculæ seminales are found.

The urethra is subservient to two purposes; the expulsion of the semen in the act of copulation, and the conveyance of the urine from the bladder. Its surface is perfectly smooth, and is covered and protected by a mucous secretion. The diameter of this canal varies slightly at different parts, but may be stated generally at about one-eighth of an inch. At its first departure from the bladder, it is surrounded for one inch by the prostate; it is then continued as a simple membranous tube, but surrounded by muscular fibres for another inch; this is called the membranous portion of the urethra. In the rest of its passage it is surrounded by a vascular substance, called corpus spongiosum; this is accumulated in a considerable mass at its commencement, where indeed the urethra is broader than in any other situation, and this is called the bulb. The seminal and prostatic liquors are poured into the bulb of the urethra, and are forcibly expelled from thence by a sort of convulsive contraction of a muscle, whose fibres surround this part of the canal; the ejaculator seminis. The glans penis is nothing more than a portion of the same vascular mass, which surrounds the rest of the urethra, covered by a very delicate, sensible, and finely organized integument.

The bulb, corpus spongiosum, and glans, are susceptible of the same erection as the body of the penis; which is indeed essential to the performance of their functions, in conveying the fecundating liquor into the body of the female.

The penis consists of two bodies, called crura, or corpora cavenosa, which arise separately from the bones of the pelvis; but join so as to form afterwards a single organ. Each crus consists of a very strong and dense ligamentous tube, filled internally with cellular substance, into the cells of which the arteries open, and from which the veins commence. The arteries pour the blood into these organs with great energy, in obedience

to the passions of the mind, and thereby distend the ligamentous tubes until they feel perfectly hard and rigid, in which state the whole organ is fitted for the function which it has to perform in the act of copulation. The urethra, surrounded by its spongy substance, runs along the under surface of the corpora cavernosa, and the glans penis is situated at the anterior extremity of these parts.

The body of the penis is covered by common integuments, which, being adapted to cover the organ in its extended state, fall into wrinkles when it is collapsed. These are continued beyond the end of the glands, and are inflected, so as to form a hood or covering to the glans, called the prepuce. The latter part is connected to the mouth of the urethra by a small fold named the frenum. The surface of the glans, and the lining of the prepuce, are smeared with an unctuous matter of peculiar odour, furnished by some small glands.

OF THE BRAIN AND NERVES.

The brain is a soft and somewhat white substance, situated in the cavity of the skull, and corresponding in form to that cavity. Its parts are supported by a firm membrane, called the dura mater, and its substance is more immediately invested by a delicate membrane, called the pia mater.

The structure of the brain is remarkably constant and uniform; very seldom deviating from the accustomed standard. Varieties of formation occur, not unfrequently, in most other parts of the body; but the parts of the brain preserve an almost invariable relation of form, position, magnitude, and connection; which seems to prove, that the right performance of the functions of this organ requires an exactness in the structure of individual parts.

According to Sœmmerring, the weight of the brain varies from *2lb. 5½oz.* to *3lb. 3¾oz.* Of two hundred brains, which this anatomist examined, none weighed four pounds, whereas Haller states its weight as amounting in general to five pounds. The weight of the brain, compared to that of the body, is an inverse ratio to the age of the subject. In young fœtuses it is soft and almost fluid: it becomes of a more solid consistence in increasing age, and is firmest in old persons.

The dura mater is a very firm and compact membrane, adhering closely by vessels and fibres to the internal surface of the cranium. It is therefore to be regarded as the periosteum of the internal table of the cranium, as well as a membrane for supporting and investing the brain. It is described by anatomists as consisting of two layers, intimately connected in general, but separated from each other at particular parts, so as to leave vacancies between them, called sinuses, into which the veins of the brain pour their blood. The chief of these are, the superior longitudinal, the two lateral, and the torcular herophili. There are besides some smaller ones, as the inferior longitudinal, the cavernous, the circular, the superior, and the anterior petrosal. They all terminate ultimately in the lateral sinus, which, quitting the cranium, takes the name of internal jugular vein.

On the upper part of the dura mater some small eminences are observed, arising from clusters of white granular bodies, situated between this membrane and the pia mater; they are the glandulæ Pacchioni, and fill the pits which may be observed in the skull-cap. The ramifications of the spinous artery, which is the chief nutrient vessel of the dura mater, are very conspicuous on each side of the head. The inner surface of the dura mater is smooth and shining, and has no connection with the pia mater, except where veins pass from the latter membrane to the sinuses.

The processes which the dura mater forms, for separating and supporting the different parts of the brain, are, 1. the falx cerebri; 2. tentorium cerebelli; 3. falx cerebelli.

The two membranes which immediately invest the brain were considered as one, and called the pia mater, until a more minute investigation had shewn that it could be divided into two layers. The outer one is called tunica arachnoidea. This is spread over the visible surface of the brain, is of a pale white colour, yet in in some degree transparent, very thin, and devoid of evident vessels. It is seen most evidently, where it passes between the two lobes of the cerebellum, and about the middle of the basis cerebri: in other parts it adheres so intimately to the pia mater, that the distinction can scarcely be demonstrated.

The pia mater every where covers the external surface of the brain, and therefore sends processes into all the convolutions of this organ. It is extremely vascular, and a great portion of the blood, which the brain receives, is spread out

upon its surface in minute vessels. The outer surface is tolerably smooth; the inner universally villous, from the torn orifices of innumerable vessels, which entered the substance of the brain.

The surface of the brain appears convoluted, so as to resemble the windings of the small intestines. These convolutions do not in general penetrate more than one inch, or an inch and a half, into the substance.

The contents of the cranium are divided into cerebrum, cerebellum, and medulla oblongata.

The cerebrum is the upper, and by far the largest, portion: it occupies all the superior part of the vaulted cavity of the skull, and rests below on the tentorium, the petrous portions of the temporal bones, the sphenoid alæ, and the orbits. Its upper surface presents a regularly convex oval, narrower in front than behind. It is divided into a right and left hemisphere by a deep longitudinal fissure, into which the falx cerebri descends. Each hemisphere is divided into two lobes by means of the fissura magna Sylvii. This fissure commences at the basis of the brain, opposite to the lesser ala of the sphenoid bone; the anterior lobe is that portion of the hemisphere situated in front of the fissure; and the posterior lobe is the division placed behind.

The hemispheres of the cerebrum are united together at about two inches and a half from the surface of the brain, by means of a medullary body, called corpus callosum. This is about three inches in length, and three quarters of an inch in breadth.

As there are no distinguishable parts in the upper portions of the hemispheres of the cerebrum, it is customary to pare all these away in dissection, nearly to the level of the corpus callosum, in order that we may be able more easily to open, and more particularly to examine, certain cavities, which are situated at the sides of that body, and are called the lateral ventricles.

On making a section of the brain, we perceive that it is composed of two substances; an exterior one, which is of a grey colour, and an interior one, which is white. These are simply termed the cineritious and white substances, or substantia cinerea et alba; or, from the former surrounding the latter, as the bark does the wood of a tree, they are named, in contradistinction, the cortical and medullary substances of the brain.

The two lateral ventricles are situated in the substance of the brain, by the side of the corpus callosum, (one in either hemisphere). The cavity begins in the front lobe of the brain, as far forwards as the commencement of the corpus callosum; it runs from before backwards, in a direction parallel to that body, and at its posterior end bends downwards, and returns obliquely from behind forwards, to terminate almost under its superior extremity. At the place where the ventricle bends, in order to run downwards, there is a particular elongation passing into the posterior lobe, forming a triangular-pointed cavity, and terminating in a cul de sac. This is the digital cavity, or cornu posterius, of the lateral ventricle. These and the other ventricles of the brain contain a small quantity of a watery fluid. The disease of hydrocephalus is a morbid increase of quantity in this fluid, which accumulates sometimes to the amount of some pounds, distending and dilating the ventricles enormously. The learned Sœmmerring, who may justly be esteemed the first of modern anatomists, places the censorium commune in this fluid. He has traced all the nerves of the brain to the sides of the ventricles; and concludes, that impressions made on these nerves will be transmitted to the water of the ventricles, which he considers as the organ of the soul.

The two lateral ventricles are separated by a perpendicular partition, called the septum lucidum, which passes from the corpus callosum to the fornix. It contains a small triangular cavity, called by some the fifth ventricle of the brain. It has no communication with the other cavities of the brain.

The fornix is a roundish medullary body, lying between the two ventricles at the lower part. It arises by two anterior crura from the front of the brain; these unite, to form the body or pillar of the fornix, which separates behind into two posterior crura, that run into the reflected portion of the ventricles. Under the anterior part of the fornix is a small slit-like opening, by which the two lateral ventricles communicate.

The choroid plexus is a production of the pia mater, containing a vast number of arterial and venous ramifications, floating almost loosely in the cavity of the ventricles. It is first observed in the reflected portion of the ventricle, where it is the broadest and largest: it diminishes in size as it ascends, and terminates just at the opening of communication between the two cavities. The choroid plexuses of the two ventricles are united by a middle ex-

pansion, passing under the fornix, and called the velum.

The lateral ventricle contains certain eminences, which form its sides; the corpus striatum is the anterior and superior eminence, grey on its external surface, and striated internally. The posterior eminence in each ventricle is called the thalamus nervi optici; it is hemispherical, and white, and joined to its opposite one by an union of substance, called the soft commissure. The hippocampus major is a large elongated eminence, lying in the descending portion of the lateral ventricle: and the hippocampus minor is a smaller one, in the digital cavity.

The pineal gland, or conarium, is found behind the optic thalami. Its size is about that of a small horse-bean; its colour grey, and figure conical. Two small medullary chords connect it to the optic thalami. In the substance of this body is found a small quantity of a gritty matter, nearly resembling sand. It consists of a number of semi-transparent and light yellow grains. Soemmerring, who first discovered that this belonged to the healthy structure of the brain, calls it the acervulus of the pineal gland. This little body has been more attended to and noticed than it would otherwise have been, in consequence of the chimerical dream of Descartes, who represented it as the seat of the soul.

Below the pineal gland is a square portion of the brain, divided into four superficial eminences, called corpora quadrigemina, and from these a thin production extends to the cerebellum, under the name of valvula cerebri.

By drawing asunder the optic thalami, and separating their soft commissure, we expose the third ventricle of the brain. This appears as an oblong cavity, about an inch and a quarter in length. A round medullary rope is seen in front of it, and a similar one behind; these are called the anterior and posterior commissures. A round aperture is observed under the anterior commissure, beyond which the ventricle terminates by a pointed and conical extremity, from which a short process is continued to the pituitary gland, under the name of infundibulum. The foramen commune anterius is an opening observed between the optic thalami before they are disturbed, and leading from the aperture of communication, which connects the two lateral ventricles under the fornix, into the third ventricle. Just before the posterior commissure a round opening is found, leading through a short canal, in front of the tubercula quadrigemina, to the fourth ventricle. It is named canalis medius, iter ad quartum ventriculum, or aquæductus Sylvii. Thus the four first ventricles of the brain have a free communication with each other.

Under the posterior lobes of the cerebrum there is found a transverse production of dura mater, called tentorium, which is attached to the internal transverse ridge of the occiput behind, and to the petrous portions of the temporal bone in front. Under this membrane lie the two lobes of the cerebellum, separated by a small perpendicular production, called the falx cerebelli.

The fourth ventricle is a cavity, left between the upper and posterior surface of the medulla oblongata, and the front of the cerebellum. It extends laterally to a considerable distance in the crura cerebelli: a groove runs along the middle of the medulla oblongata, which constitutes the front of the ventricle, and terminates at the end of the cavity in a point. From the lateral productions, and the pointed termination of the cavity, it has been named the calamus scriptorius.

The pituitary gland is a firm substance, differing in texture from the brain, and lodged in the sella turcica. Its name is derived from a supposition that it secreted the mucus of the nose, which in ancient times was supposed to flow from the head. It is connected by the infundibulum to the basis of the brain. Behind the last mentioned part, at the basis cerebri, are seen two small rounded eminences, called corpora subrotunda. The crura cerebri are two large medullary processes going from the cerebrum to the medulla oblongata.

The cerebellum is situated in the lower fossæ of the occipital bone, under the tentorium. It consists of an intermixture of cortical and medullary substance, arranged differently from the order observed in the cerebrum. A perpendicular section of this part discovers a very elegant structure in this respect. A thick trunk of medullary matter sends off processes, in every direction; from these other branches proceed, all of which are surrounded by cortex. This is called the arbor vitæ. The arbor vitæ constitutes the crus cerebelli on each side, and these processes join the medulla oblongata.

The medulla oblongata is a large medullary protuberance, resting on the basilar process of the occiput. Its connection with the crura cerebri and cerebelli have been already noticed. A medullary chord is continued from its posterior end, under the name of medulla spinalis.

Medulla spinalis. This is a roundish

medullary chord, about the size of the fore-finger, arising within the cranium from the medulla oblongata; leaving that cavity at the foramen magnum occipitale, and continued along the canal left in the spine to the upper lumbar vertebræ, where it terminates by forming the cauda equina.

It sends off a pair of nerves at each interval between two vertebræ. It is covered immediately by pia mater and tunica arachnoidea, and more loosely by a sheath of dura mater, which lines the whole spinal canal. It is plentifully supplied with blood vessels. The nerves come off from this body in numerous threads, quite separate from each other at first, but uniting afterwards. The cauda equina consists of the medulla spinalis, entirely resolved into a bundle of such threads.

Structure of the Nerves.—The nerves are soft, white, and fibrous chords, nearly of a cylindrical shape, arising from the brain, or medulla spinalis. When they leave the brain, the pia mater collects the fibres into larger or smaller fasciculi.

The medullary filaments of the nerves are covered by a vascular membrane, called by Reil neurilema, which detaches processes from its inner surface, to surround and invest the smaller divisions and fibres of the medullary substance. By immersing a nerve in alkali, its medulla is dissolved, and the containing membranous tubes, formed of neurilema, are left. Acids dissolve the neurilema, and leave the medullary fibres. These organs receive a considerable supply of blood from vessels ramifying on their neurilema.

By maceration in water, and careful dissection, a nervous trunk may be separated into numerous threads; and each of these, when examined in a microscope, seems to be an assemblage of proportionably smaller fibres. Greater magnifying powers shew those fibres, which before appeared simple, to be composed of still smaller threads; and it is doubtful, whether the ultimate nervous fibre can be discovered. All that is said, therefore, of the form, course, &c. of these ultimate fibres is wholly conjectural. The fibres do not proceed in a straight uninterrupted course, but join frequently with each other.

A nerve divided in the living subject retracts: the medulla is expressed from its extremities, by the contraction of its membranes, in the form of globules. If the animal be killed at some distance of time from the operation of dividing a nerve, the divided extremities are rather swoln, and are connected by a newly formed matter. Anatomists have disputed greatly, whether or not this be a real nerve. As this question can hardly be decided by merely anatomical testimony, it appears most philosophical to inquire, whether the new matter will perform the functions of a nerve; and this has been completely proved by the experiments of Dr. Haighton, in the first part of the Philosophical Transactions for the year 1795.

In some parts of the nervous system, little tubercles, or knots, called ganglia, are found in the course of the nerve, and are usually formed by the concurrence of several branches. These bodies are of various figures, but generally flattened. They partake more of the red colour than the trunks of the nerves on which they are formed, as they possess more numerous blood-vessels. They contain nervous fibres, surrounded by a firm vascular substance.

By the term, origin of a nerve, we understand its connection with the brain or spinal marrow. This end is called its sensorial extremity, being considered as the point to which it conveys the impressions made on it by external objects, and from which it receives the commands of the will, to be transmitted to the organs which it supplies.

There is considerable difference in form, structure, and consistence, between the individual nerves.

The nerves are arranged in pairs, as they are exactly similar on both sides of the body. Hence any pair of nerves consists of the right and left nerve.

They are sometimes divided into those of the brain; and those of the medulla spinalis; or into the nerves of the organs of sense, the nerves of motion, and the mixed nerves; or, according to the nature of the parts which they supply, into voluntary and involuntary nerves.

The quantity of nerves distributed to the different structures in the body varies greatly. The organs of sense receive the most copious supply—*viz.* the eye, the nose, labyrinth of the ear, ends of the fingers, glans penis et clitoridis, and the rest of the skin. Muscles have also a large share of nerves: the blood-vessels are much more sparingly furnished. The nerves of the viscera are very small in proportion to the size of the organs. Bones, cartilages, tendons, ligaments, membranes, marrow, fat, have no discernible nerves.

Nerves ramify through the body something like arteries: thus, a nervous trunk

sends off branches: these, again divided, form ramifications: and in their further progress form twigs, filaments, &c. and this division goes on, until the nerve, from its smallness, can be no longer traced. Yet we can manifestly discern the nerves in some instances, as in the organs of sense, terminating in a pulpy expansion.

Like the arteries, nerves communicate with each other; and it is conjectured that these communications, like those of the blood-vessels, are designed to obviate the effects of the injury of compression of any particular nervous trunk. In some parts these communications are very numerous, so as to constitute a minute network of nervous filaments, called a plexus.

Description of the particular nerves.—There are in the whole body thirty-nine pairs of nerves; of which nine arise from the brain, and thirty from the spinal marrow. There is another pair, called the great sympathetic, which can hardly be ascribed to either of these classes.

Nerves of the brain.

1st. pair. Olfactory nerves; arise from the corpora striata, and go through the cribriform lamella of the ethmoid bone to the pituitary membrane of the nose.

2d pair. Optic nerves; arise from the thalami nervorum opticorum, and proceed to the eye-ball, where they are expanded to form the retinæ.

3d pair. Nervi motores oculorum; arise from the crura cerebri, and are distributed to some of the muscles of the eye-ball.

4th pair. Nervi trochleares; come from the valve of the brain, and supply the trochlearis muscle of the eye.

5th pair. Nervi trigemini; arise from the side of the medulla oblongata. This nerve divides into three branches, of which the first, or ophthalmic, goes into the orbit, and after giving a few branches there passes out on the forehead. The second, or superior maxillary, supplies the parts about the upper jaw; a remarkable branch of it is the infra-orbital, which comes through the large hole under the orbit to the face. The third, or inferior maxillary, is distributed to the lower jaw and adjacent parts.

6th pair. Nervi motores externi; from the medulla oblongata to the external straight muscle of the eye.

7th pair. Nervi auditorii. This pair consists of two nerves lying in contact, but completely distinct from each other, both in their origin, course, and distribution. The portio mollis of this nerve is distributed to the labyrinth of the ear. The portio dura goes through the temporal bone, and is very widely spread over the face. These nerves are more correctly termed nervus auditorius, and nervus facialis. The chorda tympani is a branch of communication between the facial nerve and the lingual branch of the inferior maxillary.

8th pair. Par vagum; arises from the medulla spinalis, before it quits the cranium. It receives an accessory branch, that originates from the upper portion of the medulla spinalis, contained in the cervical vertebræ. The par vagum passes along the neck, in company with the carotid artery and the internal jugular vein. It sends off in the upper part of the neck, 1. the glossopharyngeal nerve; 2. superior laryngeal; and 3. the accessory branch. The trunk that enters the chest, and gives rise to the inferior laryngeal or recurrent nerve. It afterwards becomes connected to the œsophagus, and passes the diaphragm in conjunction with that tube, to be distributed finally to the stomach; sending in its passage several branches which supply the lungs.

9th pair. Nervi linguales; arise near the former, go through the foramen condyloideum, and supply the muscles of the tongue.

Nerves of the medulla spinalis.—The cervical nerves, soon after they come out from between the vertebræ, communicate with each other. They supply all the muscles which are situated about the vertebræ of the neck. The second sends a large branch, which ramifies extensively over the occiput.

The nerve of the diaphragm, called the phrenic or diaphragmatic, arises principally from the fourth cervical nerve. It lies close on the anterior scalenus muscle, then goes over the pericardium to the diaphragm.

The four lower cervical nerves, and the first dorsal, concur in forming the axillary plexus, from which the upper extremity derives its supply. These are large nervous trunks, coming out at the side of the neck, and variously united to each other. They go behind the clavicle with the axillary artery. This plexus sends off the following branches:

1. Nervi thoracici, accompanying the thoracic arteries.

2. Nervus supra-scapularis, distributed with the artery of the same name.

3. Nervus axillaris, following the course of the posterior circumflex artery.

4. Cutaneus internus, running over the

brachial artery to the elbow, and then ramifying under the skin of the inner side of the fore-arm.

5. Cutaneus externus, distributed along the outer side of the fore-arm.

6. Median nerve, a large trunk accompanying the brachial artery, then proceeding to the hand, and supplying the thumb, with the two neighbouring fingers, and the radial side of the ring finger.

7. Radial nerve, bends round the os humeri, from the inner to the outer side of the bone; it is distributed superficially to the back of the hand and fingers.

8. Ulnar nerve, accompanying the nerve of the same name to the hand, where it supplies the little finger, and the ulnar side of the ring finger.

The twelve pairs of dorsal nerves supply the muscles in their neighbourhood. They give also numerous branches of communication to the great sympathetic.

The five pairs of lumbar nerves send branches to the neighbouring muscles, and give communicating filaments to the great sympathetic. They also produce two nerves distributed to the front of the thigh; *viz.* the anterior crural, which goes out of the pelvis near the external iliac artery, and has an extensive distribution to the thigh and leg; and the obturator nerve, which belongs also to muscles on the front of the thigh.

The sacral nerves give communicating branches to the great sympathetic; and several filaments to the organs of generation in both sexes, to the bladder, rectum, &c. They mostly, however, unite to form the great sciatic nerve, which is the largest trunk in the body. It goes out of the pelvis at the back part, and passes to the thigh. Here it sometimes is pressed by the weight of the body in sitting, and causes the effect of the foot going to sleep, as it is expressed in common language. This nerve is distributed to the back of the thigh, and over the whole leg and foot.

Great sympathetic or intercostal nerve.—It is first formed by a small filament of the 6th pair, or nervus motor externus, together with another derived from the pterygoid branch of the superior maxillary. In the upper part of the neck this nerve has a very large ganglion lying on the vertebræ, called the superior cervical ganglion. This ganglion receives branches of communication from the five upper pairs of cervical nerves, and sends off a branch to the heart. The trunk descends along the neck, and forms an inferior cervical ganglion, which has communicating filaments from the neighbouring spinal nerves, and sends several branches to the heart, forming the cardiac plexus. The sympathetic nerve then passes through the chest, over the heads of the ribs, receiving branches from each dorsal nerve, and forming a dorsal ganglion between every two vertebræ. In its course it sends off the splanchnic nerves, which go through the diaphragm, and form a vast and most intimate plexus about the root of the cæliac artery, called the cæliac plexus, from which the liver, pancreas, spleen, large and small intestines, and kidnies, derive their nerves. All these organs receive several filaments, united so as to form plexuses, and surrounding their arterial trunks.

The trunk of the great sympathetic enters the abdomen, and goes over the lumbar vertebræ, receiving branches of communication, and forming lumbar ganglia; it is then continued along the front of the sacrum, where the sacral nerves supply communicating filaments, and where five sacral ganglia are formed.

ORGANS OF SENSE.

Organ of vision.—The globe of the eye is contained in a bony socket, formed by the bones of the cranium and of the face. It is furnished with muscles which can move it in every direction, and surrounded by a very soft and delicate kind of fat, which yields to it in all its motions. It is composed of certain membranes, called its tunics or coats, and of other parts termed humours.

Its figure is very nearly spherical; but the transparent portion in front is the section of a smaller sphere than the globe. The optic nerve, to which the eye-ball is attached posteriorly, enters considerably on the inside of the axis of the eye.

The coats of the eye are disposed concentrically; and the exterior, which is very dense, firm, and tough, is called the sclerotica. This does not cover the whole globe, but leaves a circular opening in front, filled by the transparent cornea, which, although pellucid, is a very firm and strong membrane. Hence, the sclerotica and cornea together form a very complete exterior case, which defends and supports the more delicate parts within. The necessity of having the front of the globe transparent, for the purpose of admitting the rays of light, is obvious.

Under the sclerotica a soft and vascular membrane surrounds the eye-ball, and is called the choroid coat. It is connected

to the sclerotica by a loose adhesion, which can be destroyed by blowing air between the membranes; but in front this adhesion is stronger, and forms a white circle named orbiculus or ligamentum ciliare. The colour of the choroid coat is a deep brown, approaching to a black, and this colour is derived from a substance called pigmentum nigrum, which separates from the choroid by maceration, and dissolves in water so as to render it turbid.

The inner surface of the choroid coat, which is universally coloured by pigmentum nigrum in the human subject, is sometimes called tunica ruyschiana, as Ruysch endeavoured to prove that it formed a distinct membrane from the external part. It is this inner surface that possesses the brilliant colours observable in animals, whence the appellation of tapetum. This surface lies in contact with the retina, but does not adhere to that membrane. On the front of the eye, however, and beyond the anterior margin of the retina, the choroid is closely attached by means of numerous and very delicate folds, called the ciliary processes, to the surface of the vitreous humour, round the margin of the crystalline lens.

The iris is a membrane continued transversely across the eye-ball, behind the cornea, and appearing as a continuation of the choroid from the orbiculus ciliaris. The round opening in the front of this membrane is called the pupil; it allows the passage of the rays of light into the interior of the eye. This aperture varies in its dimensions according to the quantity of light to which the organ is exposed: a strong light causes the pupil to become contracted, in order to exclude a portion of the rays of light which offend the organ. The aperture is dilated in a weak light, to let in as many rays as possible. Some anatomists have thought proper to employ themselves in debating at length, whether these motions arise from a really muscular structure or no; but we believe that they have not yet settled the point completely.

The name of iris was applied to this part, from the diversity of colours observable in it in different individuals; and it is the colour of this that produces the colour of the eye, in the popular sense of the phrase. There is a remarkable correspondence in this point between the skin and hair and the iris. A light complexion and hair is accompanied with blue, grey, or the lighter colours of the iris; while a dark skin and black hair are attended with the dark brown iris.

In that curious variety of the human race called the Albinos, where the skin and hair are of a dead milk-white hue, in consequence of a total absence of the rete mucosum or colouring principle, the colouring matter of the iris and choroid is also deficient, and these parts appear red, from the numerous blood-vessels which they contain.

The posterior surface of the iris is covered by pigmentum nigrum, and is called the uvea.

Under the choroid coat is found a third membrane of the eye-ball, called the retina, which is formed by the expansion of the medullary substance of the optic nerve, and forms the immediate organ of vision. It is of a yellowish grey colour, and so extremely soft as almost to be lacerated by the slightest touch. Its outer surface is entirely unconnected with the choroid coat; and the inner surface is expanded on the vitreous humour, but not connected to it. It terminates in front by a distinctly defined edge, where the ciliary processes begin to adhere to the vitreous humour. On the inside of the retina are seen the branches of an artery and vein, which enter through the centre of the optic nerve, (arteria et vena centralis oculi). The part at which it enters the eye is termed the porus opticus, and is of course insensible; and hence physiologists have explained the reason why the optic nerve is inserted out of the axis of the eye; as otherwise the axis of vision would have fallen on an insensible part of the retina.

On the outer, or temporal side of the retina, there is a fold of the membrane of a bright yellow colour, in the recent state, and there is also said to be an aperture. These circumstances were first pointed out by Soemmerring, and have been named after him.

The vitreous humour occupies the greatest share of the globe of the eye. It consists of a clear water contained in a cellular substance, which is so perfectly transparent as to resemble pure glass, whence its name is derived. The cellular substance is condensed on the surface into a smooth membrane, called the membrana hyaloidea. This is marked in front by a circular series of black radiated lines, caused by the adhesion of the ciliary processes, which, like other parts of the choroid, are covered with pigmentum nigrum. Under these a circular canal runs, named the canal of Petit.

The crystalline humour or lens is imbedded in the front of the vitreous humour. Its size is about that of a pea, but it is much more flattened in form. It is of a waxy consistence, softer externally, and growing gradually firmer towards the cen-

tre. The lens is contained in its proper capsule, the posterior surface of which adheres firmly to the tunica hyaloidea; but its separation can sometimes be effected without rupturing it. It has no apparent connection to this capsule. It is an opaque state of this body that constitutes the disease called cataract.

The aqueous humour is a small quantity of transparent water, placed immediately behind the cornea, and occupying the space between that membrane and the crystalline lens : it is easily reproduced when let out.

In the midst of the space occupied by this humour the iris is found, and it divides the space into two portions, called the anterior and posterior chambers of the eye; which communicate by means of the pupil. The anterior is much the largest of these.

The choroid coat, ciliary processes, and iris, are very vascular, and derive their supply from the ciliary branches of the ophthalmic artery.

The iris is very largely supplied with nerves from a small ganglion, named lenticular, formed on a branch of the nervus motor, or nerve of the third pair. These are called the ciliary nerves.

Of the eye-lids and lacrymal apparatus.— The eye-ball is covered by two moveable curtains, formed by a folding of the common integument, and called the eye-lids. In order to keep these uniformly expanded, and to prevent them from forming wrinkles, each of them contains a thin portion of cartilage, adapted in figure to the convexity of the globe, and called the tarsus. In order to provide still further for the greatest possible facility of motion, the eye-lids are lined by a smooth and polished membrane, and the globe of the eye is covered by the same membrane, on its anterior part: this is called conjunctiva, as it serves to connect the front of the eyeball to the eye-lids.

The junctions of the eye-lids are called the internal and external canthus, or angle of the eye.

They are opened by the levator palpebræ lifting up the upper lid; and this muscle is in a state of constant action so long as we keep our eyes open. They are closed by the circular orbicularis palpebrarum.

The cilia, or eye-lashes, are two rows of strong curved hairs implanted in the opposed edges of the two eye-lids, and admirably calculated for protecting the eye from dust or other foreign bodies

The hairy prominences above the eyelids are the supercilia, or eye-brows; these are very moveable; they serve as a protection to the eyes, and are much concerned in expressing the passions.

In order to facilitate the motions of the eye-lids and eye-balls on each other, the surface of the conjunctiva is constantly moistened by a watery and mucilaginous fluid, poured out by the arteries of the part. The incrustations of the mucilage in the night would glue the eye-lids together; but this effect is obviated by a natural ointment, formed in a very elegant grandular apparatus on the inner surface of the tarsi. We there find about 16 or 17 longitudinal parallel rows of very minute glandular bodies; and these pour out their sebaceous secretion from a series of apertures on the edges of the eye-lids. They are called the meibomian glands, and ciliary ducts.

The fluid just described is constantly formed on the surface of the conjunctiva; but on extraordinary occasions, as when an irritating foreign body is in the eye, or in consequence of affections of the mind, a fluid is poured out in greater abundance, which has the name of tears, and is secreted by the lacrymal gland. This is a small conglomerate gland, situated in the orbit, near the upper eye-lid, and having ducts which terminate on the surface of the conjunctiva; but which, on account of their minuteness, are hardly demonstrable in the human subject. The utility of this secretion in washing away any foreign substance must be sufficiently obvious.

The superfluous part of the lacrymal secretion is conveyed through two very fine tubes to a small bag, situated at the internal angle of the eye. These tubes commence by open mouths, called the puncta lacrymalia, from the inner extremities of the eye-lids, and are about equal in size to admit a hog's bristle.

There is a little fleshy projection at the corner of the eye, and between the two puncta, called caruncula lacrymalis.

The lacrymal sac is a small membranous bag, placed in the hollow formed at the inner edge of the orbit. The tendon of the orbicularis palpebrarum, which generally forms a slight eminence visible through the skin, crosses the middle of this bag.

A canal, called the ductus nasalis, and lodged in a groove of the superior maxillary bone, conveys the tears into the nose; where it terminates by an open orifice within the inferior turbinated bone.

ORGAN OF HEARING.

The organ is divided into two parts, the external and internal ear, by the membra-

na tympani. The situation of the former on the out side of the head is well known; the latter is contained in the petrous portion of the temporal bone.

The external ear consists of two parts, *viz.* the pinna, or ear, popularly so called, and a tube called meatus auditorius externus leading from the pinna to the membrana tympani. These parts serve for collecting sounds, and conveying them to the membrana tympani.

The pinna consists of a convoluted cartilage inclosed by common integuments. The lower part, which is pierced for earrings, has no cartilage, and is called the lobulus. The helix is the fold forming the external circumference of the ear; the next eminence to this, which forms the margin of the great cavity of the external ear, is called anthelix; it separates at its upper and anterior end into two processes named crura. The projection immediately in front of the meatus is the tragus, and that immediately opposite, the antitragus. The great cavity within the anthelix, and leading to the meatus, is called the concha. Several sebaceous glands are situated in the folds of the ear.

The meatus externus is formed first by a portion of cartilage, continued from the pinna, and more interiorly it consists of a canal in the substance of the bone. This bony part does not exist in the fœtus, where the meatus is wholly cartilaginous. The common integuments continued from the pinna line the meatus externus, and the cuticle is produced over the membrana tympani.

The surface of the meatus, at its commencement, is furnished with numerous fine hairs, and the canal is moistened by a secretion of an oily and inflammable nature, called cerumen. This is produced by numerous small glands, visible on the external surface of the meatus, and distinguishable by their yellowish colour. The cerumen concretes, and is collected sometimes in such quantity as to induce a slight degree of deafness, which is easily removed by syringing with warm water.

The membrana tympani, which is a circular membrane above a quarter of an inch in diameter, is stretched across the inner extremity of the meatus, and derives its name from a comparison with a drum head, to which it bears some analogy in its use. In the fœtus it is stretched on a distinct bony ring, called the annulus auditorius. This ring is deficient at its upper part, and has no bony union to the rest of the temporal bone, but it becomes united soon after birth.

This membrane is concave on its exterior surface, and convex towards the tympanum. Its position is inclined, the upper margin being more towards the outside of the head, and the under part farther inwards; so that the superior part of the meatus forms an obtuse angle, and the inferior part an acute angle, with the membrane.

The internal ear consists of two divisions, *viz.* the tympanum and the labyrinth.

The tympanum is an irregular bony cavity, which will about admit the end of a finger, hollowed out of the temporal bone, just within the membrana tympani. It has several communications with the neighbouring parts.

Opposite to the membrana tympani are two openings, which lead to the labyrinth of the ear. The upper one is named the fenestra ovalis, the lower one the fenestra rotunda, and the projection between them is called the promontory. The fenestra ovalis is filled, as we shall presently see, by one of the little bones of the tympanum, and the fenestra rotunda is closed by a membrane.

The eustachian tube, or iter a palato ad aurem, opens in front of the tympanum. It commences by an expanded cartilaginous orifice at the back of the nostrils, passes through the substance of the temporal bone, and terminates by a contracted orifice in the tympanum. Its office is to convey air into the cavity of the tympanum. The membrana tympani is thrown into vibrations by the impulse of the sonorous undulations of the air, and that vibration could not take place unless there was air in the inside as well as on the outside of the membrane. Water, or any other fluid, would not have answered the purpose. Hence an obstruction of this tube causes deafness, which surgeons have attempted to remedy by puncturing the membrana tympani. An opening in the latter membrane of a small extent does by no means injure hearing; for many persons have the power of impelling tobacco smoke, or agitating the flame of a candle, through the ear, and yet seem to have a perfect use of the organ. In these cases the air or smoke enters the eustachian tube from the throat, and passes through the unnatural aperture in the membrane.

The mastoid process of the temporal bone is composed internally of numerous cells, communicating with each other, and finally opening into the back part of the tympanum. These do not exist in the fœtus.

The cavity of the tympanum contains a chain of small bones called ossicula auditus, connected by one end to the membrana tympani, and by the other to the fenestra ovalis. Of these the first, which is compared to a hammer, is called the malleus; the second is named the incus, the third the orbiculare, and the fourth the stapes.

The malleus possesses a manubrium or handle, a long and short process, and a head which forms an articular surface.

The incus resembles a grinding tooth, with its two fangs diverging. We remark in it a body, the surface of which is hollowed out to receive the head of the malleus: a long and a short leg.

The orbiculare is of the size of a small grain of sand. It is attached to the extremity of the long crus of the incus and the stapes.

The stapes has an exact resemblance to the iron part of a stirrup; it has a head, two crura, and a basis.

The handle of the malleus is firmly connected to the membrana tympani; and hence arises the external concavity and internal convexity of the membrane. The head of that bone is joined to the body of the incus, whose long leg is articulated to the head of the stapes The basis of the stapes fills up the fenestra ovalis. The ends of the bones forming these articulations are covered with cartilage, and furnished with capsules like other joints.

The bones of the tympanum have some small muscles connected to them by which they are moved outwards, or towards the membrana tympani, and inwards, or towards the fenestra ovalis. The first of these motions relaxes, the latter stretches the membrane. The names of these muscles are, tensor tympani, laxator tympani, and stapedeus.

The nerve called chorda tympani passes across the tympanum between the handle of the malleus and the long leg of the incus.

The use of the ossicula auditus seems to be that of transmitting the vibrations of the air from the membrana tympani to the labyrinth. The final use of the muscles which moves these bones is unknown.

The labyrinth of the ear consists of three parts:—1. A spiral bony canal, twisted like a snail-shell, and thence called the cochlea. 2. Three semicircular bony canals: and 3. A small cavity, called the vestibulum, into which the cochlea and the semicircular canals open. These parts are formed of the hardest bone in the body, almost equal in solidity to ivory, and the petrous portion of the temporal bone, which incloses them, is of a similar structure. In the fœtus the labyrinth is surrounded by a softer and looser kind of bone, so that it can be most easily dissected at that age.

The vestibulum is about equal in size to a large pea, and the fenestra ovalis opens into the middle of the cavity. It has also five openings from the semicircular canals; the superior and exterior joining by one of their extremities, and opening by a common hole.

The cochlea has two turns and a half. Its canal turns round a bony centre, called the modiolus, to which is attached a thin plate of bone, projecting into the cavity of the cochlea, and named lamina spiralis. This projecting plate divides the canal of the cochlea into two parts: one opening into the vestibulum, the other at the fenestra rotunda. The latter is called the scala tympani, the former scala vestibuli.

The vestibulum, cochlea, and semicircular canals, are lined by a delicate vascular membrane, on which the portio mollis of the seventh pair of nerves is distributed. This membrane contains a clear water.

The filaments of the auditory nerve pass from the meatus auditorius internus through a number of very small apertures which lead to the labyrinth, and they terminate on the vascular membrane of the labyrinth, so that the nervous pulp is exposed almost bare to the contained fluid. The distribution of the nerve on the cochlea is particularly beautiful. The aqueducts of the ear are two very fine tubes, passing from the vestibulum and cochlea to open on the surface of the dura mater.

ORGAN OF SMELLLING.

The nose is a cavity of very irregular figure, formed chiefly by the bones of the face, and communicating with the various sinuses or bony cells formed in the head.

It is separated by the brain above by the cribriform lamella of the ethmoid bone. This separation is a perfect one, and the two cavities of the cranium and nose are wholly distinct from each other, although they are supposed, by the uninformed in anatomy, to communicate together.

The bottom of the cavity is formed by the upper surface of the pallet.

The general cavity is divided into two equal halves, called nostrils, by the septum narium, a thin and flat bony partition, descending from the cribriform la-

mella to the palate. The flat surface of the septum may therefore be said to form the inner side of the nostril; and its outer side presents three bony eminences, called the conchæ narium, or turbinated bones.

Moreover, the following excavations or sinuses open into the cavity at various parts. Two frontal sinuses; numerous cells of the ethmoid bone; two sphenoidal sinuses; and two great hollows in the upper jaw-bone, called the antra, or maxillary sinuses.

The front openings of the nostrils are well known. This aperture is heart-shaped in the skeleton, the broadest part being towards the mouth; but it is much altered in the recent subject by the apposition of pieces of cartilage, the broadest of which are the lateral portions, termed alæ nasi. Behind, the nostrils open by large apertures into the upper and anterior part of the pharynx, above the velum pendulum palati.

The sides of the bony cavity just described are covered by a thick, soft, and very vascular membrane, called membrana schneideriana, or pituitaria. Its surface is constantly moistened by a secretion of mucus from the arteries, with which it is very copiously supplied. This prevents the effects which the current of air in respiration would otherwise produce, of drying the membrane. It is only an increased quantity of this secretion, altered too somewhat in its quality, that is discharged from the nose in colds, and which is popularly supposed to come from the brain. This membrane extends into the cells which communicate with the nose, but is thinner and less vascular there.

The ethmoidal cells open into the cavity of the nose, partly above, and partly under, the loose edge of the superior turbinated bone. The frontal sinuses open into the front of these cells; and the sphenoidal sinuses into the back part of them. The antrum maxillare has a round opening between the two turbinated bones. The nasal duct opens under the inferior of these bones: and the expanded orifice of the eustachian tube is just at the communication between the back of the nose and the pharynx.

The filaments of the olfactory nerves, having penetrated the cribriform lamella, are distributed to the pituitary membrane that covers the septum nasi and superior turbinated bone.

Several small branches from the fifth pair are also distributed on the nose, at different parts.

ORGAN OF TASTE.

It would be a waste of words to describe the situation and form of the tongue. This organ presents a most interesting subject to the phisiologist, from the concern which it has in the functions of mastication, deglutition, and articulation, besides that it constitutes the organ of the sense of taste.

Its bulk is made up of numerous muscles, which are distinct at their origin, but become mixed and confused at their insertion into the tongue. The union of these fibres with each other, and with the fatty substance which connects them, constitutes the peculiar substance of the tongue. It is covered externally by a continuation of the common membrane of the mouth. This membrane, however, on the edges, tip, and upper surface of the organ, is covered with small projecting processes, called papillæ, in which the sense of taste resides.

Towards the back of the tongue several mucous glands are found, with openings that would admit a bristle. These secrete a fluid, to facilitate the passage of the food through the isthmus faucium.

Next to these openings, and still at the posterior part of the organ, are found eight or ten large papillæ, arranged in the form of the letter V, with the pointed part towards the throat. These are the pipillæ magnæ or capitatæ. They consist of a round body, surrounded by a circular fold of membrane. These also are mucous glands.

The most numerous class of papillæ are those which occupy the sides and tip of the tongue. These are the smallest in size, so as to have been compared to the villi of the skin; and conical in shape. They are called papillæ conicæ or villosæ. Among these a few larger ones are scattered, the papillæ semilenticulares.

The tongue receives three large nerves on each side; 1st, the glossopharyngeal branch of the eighth pair, distributed to the back of the tongue and upper part of the pharynx: 2ndly, the lingual nerve, or nerve of the 9th pair, which supplies the muscles: and 3rdly, the lingual branch of the inferior maxillary, which goes to the papillæ chiefly.

ORGAN OF THE SENSE OF TOUCH.

This sense may be considered, in the most enlarged acceptation of the term, as residing in the surface of the body in general: in a more limited view, we regard

the ends of the fingers as more particularly adapted, by their organization, for exploring the tangible properties of bodies.

The skin, or exterior covering of the body, is divided into three layers, *viz.* the cuticle, the rete mucosum, and the cutis. These parts are called the common integuments of the body. To them a fourth is sometimes added, *viz.* the adipous membrane. But although there is generally a layer of fat under the skin, this is not invariably the case.

The cutis vera, or true skin, is a very dense and compact membrane, formed, as it were, by a general condensation of the cellular substance on the surface of the body. It is this that forms leather, when subjected to the operation of tanning. Its thickness varies in different parts of the body. It possesses considerable elasticity, by virtue of which it yields to any distending power, and on the cessation of such force recovers its former state. It has also a species of contractility, which is evinced by its corrugation from cold. Its colour in the inhabitants of all countries is white. It possesses great vascularity, and has also an abundant supply of nerves, which bestow on it acute sensibility. It is thrown into folds in different parts of the body, in consequence of their motions on each other; this may be particularly observed in the hands and fingers. Its surface is also marked by lines, crossing and intersecting each other variously, and intercepting spaces of all shapes and descriptions.

Such parts of the cutis as are the most highly organised have numerous fine hair-like processes, called villi. These are more vascular than other parts, and receive also a more copious supply of nerves. Such parts enjoy a higher and more acute sensibility. This is the case with the ends of the fingers, which, both by their form and organization, are more especially fitted to act as organs of touch. It is also observed in the lips, and in the glans penis.

The rete mucosum is a soft mucous substance, readily demonstrable in the negro, where it is thick and of a black colour, but hardly discernible in the European. This is the seat of the colouring matter of the skin.

The cuticle is a thin semi-transparent covering, possessing no particular arrangement of parts, no vessels nor nerves. It adheres, however, closely to the subjacent parts, and is exactly moulded to the surface of the cutis. It is best seen after the action of a blister, when it is elevated by an effusion of fluid under it. In the dead body it may be separated from the cutis by putrefaction, or by immersion in hot water. In this way it may be removed, entire, from the hand and fingers, so as to resemble a glove.

It forms an insensible medium, interposed between the nerves of the organ of touch and external objects; and as it covers the whole exterior of the body, our surface is actually dead. When removed from any part, it is speedily renewed by the cutis. Its thickness varies in different parts; being greatest where it is exposed to friction, as in the palms and soles. Its thickness is here also increased by friction, as we may observe, by contrasting the hand of a labourer with that of a person who does not use his hands in the same rough manner.

It appears that the cuticle is impervious to fluids, as the serum contained in a blistered part does not transude; neither does a dead body become dried while covered by this expansion; but when that is removed, it is speedily reduced by evaporation to a state of dryness. Yet it must be penetrated by the vessels in a living body, as is proved by the immense discharge both of sensible and insensible perspiration. Probably, also, the absorbents open on it by patulous orifices; for mercurial ointment, rubbed on the skin, affects the system.

Sebaceous glands are formed under the skin, in a few situations only, as about the nose and external ear.

Hairs consist of an insensible excrescence produced from the cutis. Each hair grows from a small bulb, and is lengthened by means of additions made to it in the bulb. These bodies perforate the cuticle.

Nails are portions of a horny substance, connected to the ends of the toes and fingers. Their surface, corresponding to the back of the finger, is convex, and tolerably smooth; the opposite part is laminated and concave. These laminæ adhere to corresponding ones of the cutis. The integuments advance for some length over the root of the nail, so as to cover a considerable portion of it; and the cuticle adheres closely to its surface. The nail grows like the hair, by additions from below.

The account of the progress of the embryo after conception, or the description of the gravid uterus and its contents, together with the enumeration of those circum-

stances of anatomical structure, which are peculiar to the fœtus, will be given under the article Fœtus.

EXPLANATION OF THE ANATOMICAL PLATES.

PLATE I.

Fig. 1. *A front view of the skeleton.*

1. The cranium.
2. Os frontis.
3. 3. The orbits.
4. Upper jaw-bone.
5. Teeth.
6. Lower jaw-bone.
7. The seven true ribs.
8. The five false ribs.
9. First bone of the sternum.
10. Second bone of the sternum.
11. Ensiform cartilage.
12. The five lumbar vertebræ.
13. Ilium, or haunch-bone.
14. Os ischii.
15. Os pubis.
16. Os sacrum, or bone of the rump.
17. Symphisis pubis.
18. Thigh-bone.
19. Head of the thigh-bone.
20. Trochanter major.
21. Patella, or knee-pan.
22, 23. External and internal condyles of the thigh.
24. Tibia.
25. Fibula.
26. Bones of the tarsus.
27. Bones of the metatarsus.
28. Bones of the toes.

a. The clavicle, or collar-bone.
b. Scapula, or shoulder-blade.
c. Humerus, or bone of the arm.
d. Ulna.
e. Radius.
f. First row or phalanx of carpal bones.
g. Second row or phalanx of carpal bones.
h. Bones of the metacarpus.
i. First phalanges of the fingers.
k. Second phalanges of the fingers.
l. Third phalanges.
m. Three phalanges of the thumb.

Fig. 2. *View of the right ventricle and pulmonary artery laid open.*

These parts are marked A *a* in Plate VI. Fig. 1.

a. A triangular flap of the fleshy side of the ventricle, turned back, to expose the cavity.

b. Columnæ carneæ of the heart.

c. Tricuspidal valve.

d. The three semilunar valves in the mouth of the pulmonary artery, which is slit open.

e. e Cut edges of the ventricle.

Fig. 3. *View of the cavity of the left ventricle, and mouth of the aorta.*

a. a. Cut edges of the ventricle.
b. Columnæ carneæ.
c. Chordæ tendinæ.
d. Mitral valve.
e. Semilunar valves of the aorta.

PLATE II.

Fig. 1. *Back view of the skeleton.*

1. 2. Ossa parietalia.
3. Os occipitis.
4. Os temporis.
5. Mastoid process of the temporal bone.
6. The seven cervical vertebræ.
7. The twelve dorsal vertebræ.
8. The five lumbar vertebræ.
11. Os sacrum, or rump-bone.
12. Os coccygis, or crupper bone.
13. Ilium.
9. Ischium.
14. Neck of the thigh-bone.
15. Trochanter major.
16. Trochanter minor.
17. Condyles of the thigh.
18. Malleolus externus.
19. Malleolus internus.
20. Os calcis.

Fig. 2. *The small bones contained in the tympanum of the ear.*

1. Malleus.
2. Incus.
3. Os orbiculare.
4. Stapes.

Fig. 3. *A view of the same bones, as joined to each other, and as connected to the membrana tympani.*

e. Membrana tympani with the handle of the malleus connected.

f. Head of the malleus joined to

g, which is the body of the incus.

h. Base of the stapes.

Fig. 4. *A view of the labyrinth of the ear.*

a. Three semicircular canals unopened.

b. Section of the cochlea.

c. Auditory nerve.

d. Branches of the nerve going to the vestibulum and semicircular canals.

e. Trunk of the nerve most beautifully

ramified on the solid axis, and projecting bony plate of the cochlea.

Fig. 5. *Second view of the labyrinth; representing the vestibulum and semicircular canals laid open, and the branches of the auditory nerve terminating on those parts.*

a. Cavity of the vestibulum.

PLATE III.

Fig. 1. *A front view of the muscles.*

The right side of the figure represents the first or most superficial stratum: on the left side the second layer is exhibited. It would be impossible to refer to all the muscles exhibited in this and the following muscular plates: we must therefore confine ourselves to the more obvious and important ones.

a. Orbicularis palpebrarum.
b. Orbicularis oris.
c. Zygomatici.
d. Sterno-cleidomastoideus.
1. Platysma myoides.
2. Pectoralis major.
e. Latissimus dorsi.
3. Obliquus externus abdominis.
4. Rectus abdominis.
+ Pectoralis minor.
f. Serratus anticus.
g. Obliquus externus abdominis.
5. Deltoid muscle.
6. Biceps flexor cubiti.
h. Supinator radii longus.
i. Pronator radii teres.
k. Flexor carpi radialis.
l. Extensors of the thumb.
m, n. Two heads of the biceps flexor cubiti.
o. Opponens pollicis.
p. Muscles of the little finger.
q. Flexor tendons of the fingers.
r. Flexor digitorum profundus.
s. Flexor longus pollicis.
7. Tensor vaginæ femoris.
8. Sartorius.
9. Vastus externus.
10. Rectus extensor femoris.
11. Vastus internus.
12. Tibialis anticus.
13. Extensor muscles of the toes.
14. Extensor tendons of the toes.

Fig. 2. *Posterior surface of the eye-lids, with the lacrymal gland.*

a, b. Posterior surface of the eye-lids. The perpendicular parallel lines are formed by rows of the sebaceous or meibomian glands.

c. c. c. c. Cut edge of the tunica conjunctiva, where that membrane was reflected from the eye-lids to the eye-ball.

d. Lacrymal gland.

e. Openings of its ducts on the surface of the conjunctiva.

f. Pucta lacrymalia.

g. Caruncula lacrymalis.

Fig. 3. *Front view of the eye-brow and eye-lids; designed to shew the margins of the latter, and their union with each other.*

b. Fold of the skin between the upper eye-lid and the eye-brow.

c. Orifices in which the hairs of the eye-lash were implanted.

f. Openings of the ducts of the sebaceous glands along the margin of the eye-lid.

d. m. Superior and inferior punctum lacrymale, or external openings of the canals, by which the tears are conveyed to the lacrymal bag.

h. Carunçula lacrymalis.

g. External canthus or angle of the eye; the opposite part is the internal canthus.

Fig. 4. *View of the lacrymal passages.*

a. a. Puncta lacrymalia.

b. b. Lacrymal ducts, commencing from the puncta, and terminating in

c. The lacrymal bag.

d. Nasal duct.

e. Its termination at the nose.

f. Lacrymal gland.

PLATE IV.

Fig. 1. *A posterior view of the muscles; in which the right side exhibits the superficial, and the left a deeper-seated stratum.*

a. Temporal muscle.
b. Supraspinatus.
c. Infraspinatus.
d. Teres minor.
e. Teres major.
f. Pyriformis.
g. Vastus externus.
h. Biceps flexor cruris.
i. Semitendinosus.
k. Peronei muscles, &c.
l. Their tendons.
m. Levator scapulæ.
1. Trapezius.
2. Rhomboideus.
3. Latissimus dorsi.
4. Splenius capitis.
5. Complexus.

6. Serratus inferior posticus.
7. 7. Sacrolumbalis and longissimus dorsi.
8. Deltoid.
9. 9. Triceps extensor cubiti.
11. Gluteus maximus.
12. Gluteus medius.
13. Flexors of the knee-joint.
14. Gastro-cnemius.
15. Soleus.
16. Tendo achillis.

Fig. 2. *A view of the surface of the brain, exposed by removing the skull-cap.*

On the right side the brain is covered by its dura mater: that membrane is cut through, and turned aside, so as to expose the left hemisphere.

Fig. 3. *The skull and brain cut through horizontally in about the middle.*

It shews the difference of the cortical and medullary substances, and the union of the two hemispheres by the corpus callosum.

d. The dura mater, which covered the brain, and formed the falx, thrown back.
e. e. Cineritious substance.
g. Medullary substance.
h. Corpus callosum.

Fig. 4. *The basis of the brain, with the origin of the nerves.*

a. a. Anterior lobes of the brain.
b. b. Middle lobes.
c c. Posterior lobes.
d. d. Two lobes of the cerebellum.
f. Pons varioli, or medulla oblongata.
e. Medulla spinalis.

PLATE V.

Fig. 1. *Superficial view of the contents of the abdomen*

d. d. Omentum.
c. c. Liver.
f. f. f. f. Various convolutions of small intestine.
a. a. a. Transverse arch of the colon covered by the omentum.

Fig. 2. *is a scheme to represent the whole tract of the intestinal canal, as the stomach and some other parts do not come into view in the preceding figure. The arrows represent the course of the aliment.*

a. End of the œsophagus.
B. The stomach.
h. Pylorus.
g. i. k. l. Various convolutions of small intestine.
e. Caput coli.
m. Appendix vermiformis.
f. Ascending colon.
a. a. a. Transverse arch of the colon.
b. Sigmoid flexure of the colon.
c. Rectum.

PLATE VI.

Fig. 1. *A view of the heart and lungs, with the adjacent large blood-vessels of the thorax and abdomen.*

A. Right ventricle of the heart.
e. Right auricle.
1. 2. 3. The three lobes of the right lung.
4. 5. Two lobes of the left lung.
a. Origin of the pulmonary artery.
b. Arch of the aorta.
x. Arteria innominata.
y. y. Right and left carotid arteries.
u. u. Jugular veins.
E. E. Left subclavian vein.
c. Superior vena cava.
k. Descending aorta, sending off different branches to the abdominal viscera; as, *l,* the cœliac; *m.* superior mesenteric; *n.* inferior mesenteric; *o. p.* renal arteries.
h. Trunk of the inferior vena cava.
r. q. Renal veins.
v. Trunk of the absorbing system, called the thoracic duct.
d. Termination of that duct in the angle formed by the junction of the left subclavian and jugular veins.

Fig. 2. *A view of the thorax and abdomen, representing some parts not seen in Plate V. and now exposed by lifting up the liver.*

1. Thyroid gland.
2. Trachea. The large blood vessels correspond to those of the preceding figure.
3. The heart.
4. Left lung.
5. Right lung.
6. Under surface of the left lobe of the liver.
7. Under surface of the right lobe.
8. The stomach.
9. Great omentum.
10. Small intestines.
11. 11. The coverings of the abdomen cut through and turned aside.
12. Bladder of urine.

13. Lesser omentum.
14. Gall-bladder.

Fig. 2. *Gall-bladder and biliary ducts, and pancreas.*

K. Hepatic duct, formed by various branches coming from the liver.
L. Cystic duct.
I. Gall-bladder.
N. Ductus communis.
P. Pancreas with its duct.
Q. A portion of the intestines, with a longitudinal slit, the opening of the united ducts.

ANAXAGORAS, in biography, a celebrated philosopher among the ancients. He was born in Ionia about the 70th olympiad, became the disciple of Anaximenes, and was afterwards a lecturer himself at Athens. In this city he was cruelly persecuted, and at length banished. He went to Lampsacus, where he was greatly honoured during his life, and still more respected after his death. Statues have been erected to his memory.

Anaxagoras was a mathematician, and wrote, during his imprisonment at Athens, upon the quadrature of the circle. As a philosopher, he introduced some important innovations, as they were then called, but which redound much to his honour: he maintained, in opposition to the common systems of a plurality of Gods, that an infinite mind is the author of all motion and life. Plato asserts, that Anaxagoras taught that "mind was the cause of the world, and of all order," and that, "while all things else are compounded, this alone is pure and unmixed:" he ascribes to this principle two powers, *viz.* to know, and to move. Testimonies to this purpose in favour of Anaxagoras are numerous; Plutarch, speaking of the Ionian philosophers who flourished before this great man, says, that they made fortune, or blind necessity, the first principle in nature; but Anaxagoras affirmed, that a pure mind governs the universe. By Diogenes Laertius he is represented as the first person, "who superadded mind to matter." He died in the year 428 before Christ, and throughout his life he supported the character of a true philosopher. Superior to the motives of avarice and ambition, he resigned in early life a patrimony, that would have secured him distinction and independence, in order that he might give himself up wholly to the pursuits of science, and in the midst of the vicissitudes of fortune preserved an equal mind. Being asked, just before his death, whether he wished to be carried for interment to his native city, he replied, "it is unnecessary: the way to the regions below is every where alike open:" and in answer to a message sent him at the same time by the senate of Lampsacus, requesting to be informed in what manner they might honour his memory after his decease, he said, "By ordaining the day of my death to be annually kept as a holiday in all the schools of Lampsacus." This request was complied with, and a festival called Anaxagoria was instituted on the occasion.

ANAXIMANDER, in biography, a very celebrated Greek philosopher, was born at Miletus on the 42d olympiad; for, according to Apollodorus, he was 64 years of age in the second year of the 58th olympiad. He was one of the first who publicly taught philosophy, and wrote upon philosophical subjects. He was the kinsman, companion, and disciple of Thales. He wrote also upon the sphere and geometry, and framed a connected series of geometrical truths: he also wrote a summary of his doctrine, and carried his researches into nature very far, for the time in which he lived. It is said that he discovered the obliquity of the zodiac; that he first published a geographical table; that he invented the gnomon, and set up the first sun-dial in an open place at Lacedæmon. He is said to have been tho first who delineated the surface of the earth, and marked the divisions of land and water upon an artificial globe. He taught, that an infinity of things was the principal and universal element; that this infinite always preserved its unity, but that its parts underwent changes; that all things came from it; and that all were about to return to it. He held that the worlds are infinite; that the stars are composed of air and fire, which are carried about in their spheres, and that these spheres are gods; that the sun has the highest place in the heavens, the moon the next, and the planets and fixed stars the lowest; that the earth is a globe, placed in the middle of the universe, and remains in its place, and that the sun is 28 times larger than the earth.

ANCHOR, in maritime affairs, an extremely useful instrument, serving to retain a ship or boat in its place.

It is a very large and heavy iron instrument, with a double hook at one end, and a ring at the other, by which it is fastened to a cable.

It is cast into the bottom of the sea, or rivers, where, taking its hold, it keeps ships from being drawn away by the wind, tide, or currents.

The parts of an anchor are: 1. The

ring to which the cable is fastened: 2. the beam, or shank, which is the longest part of the anchor: 3. the arm, which is that which runs into the ground: 4. the flouke or fluke, by some called the palm, the broad and peaked part, with its barbs, like the head of an arrow, which fastens into the ground: 5. the stock, a piece of wood fastened to the beam near the ring, serving to guide the fluke, so that it may fall right, and fix in the ground.

The following are the dimensions of the several parts of an anchor, as given by M. Bougier. The two arms generally form the arch of a circle, the centre of which is 3-8ths of the shank from the vertex, or point where it is fixed to the shank; each arm is equal to the same length or radius, so that the two arms together make an arch of 120 degrees: the flukes are half the length of the arms, and their breadths two fifths of the said length. With respect to the thickness, the circumference of the throat or vertex of the shank is generally made about 1-5th part of its length, and the small end two thirds of the throat: the small end of the arms of the flukes three fourths of the circumference of the shank of the throat.

Cast iron anchors have been proposed, and indeed, from the improvements in this metal, it is probable they would be cheap and serviceable But when we consider the great importance of anchors to the lives and property intrusted in shipping, it would not be an act of prudence to make an anchor of any material but the very best. It appears reasonable, that a cast iron anchor, made broad in the flukes, and strong in the shank, and fortified with a kind of edge-bar, knee, or bracket, in each angle, between the arm and the shank, might prove as trust-worthy as a forged anchor, and be more than equal to the strain of any cable which is made.

There are several kinds of anchors: 1. the sheet anchor, which is the largest, and is never used but in violent storms, to hinder the ship from being driven ashore: 2. the two bowers, which are used for ships to ride in a harbour: 4. the stream anchor: 5. the grapnel. The iron of which anchors are made ought neither to be too soft nor too brittle; for, if the iron be brittle, the anchor is apt to break, and if it be too soft, the anchor will bend. In order to give them a proper temper, it is the practice to join brittle with soft iron, and for this reason the Spanish and Swedish iron ought to be preferred.

The shank of an anchor is to be three times the length of one of its flukes, and a ship of 500 tons hath her sheet anchor of 2000 weight; and so proportionably for others smaller or greater, although Aubin observes, that the anchors of a large vessel are made smaller in proportion than those of a small one.

The anchor is said to be a-peak, when the cable is perpendicular between the hawse and the anchor.

An anchor is said to come home, when it cannot hold the ship. An anchor is foul, when, by the turning of the ship, the cable is hitched about the fluke. To shoe an anchor, is to fit boards upon the flukes, that it may hold the better in soft ground. When the anchor hangs right up and down by the ship's side, it is said to be a cock bell, upon the ship's coming to an anchor.

The inhabitants of Ceylon use large stones instead of anchors; and in some other places of the Indies, the anchors are a kind of wooden machines loaded with stones.

ANCHORAGE, in law, is a duty taken of ships for the use of the port or harbour where they cast anchor: for the ground there belonging to the king, no man can let fall anchor thereon, without paying the king's officers for so doing.

ANCHUSA, in botany, the *alkanet*, a genus of the Pentandria Monogynia class of plants, the calyx of which is an oblong, cylindric, acute perianthium, divided into five segments, and permanent; the corolla consists of a single petal; the tube is cylindric, and of the length of the cup; the limb is lightly divided into five segments, erecto-patent and obtuse; the opening is closed by five oblong, convex, prominent, and connivent squamulæ: there is no pericarpium: the cup becomes larger, and serves as a fruit, containing in its cavity four oblong, obtuse, and gibbous seeds. There are thirteen species: though according to Martyn only ten. They are mostly biennial, except when they grow in rubbish, or out of a wall. They may all be easily propagated by seeds, sown in the autumn.

ANCISTRUM, in botany, a genus of the Diandria Monogynia class and order: calyx four leaved: no corolla: stigma many-parted: drupe dry, hispid, one celled. There are three species. A. decumbens resembles burnet in the herb and manner of flowering: it is remarkable for the yellow awns to the calyx, resembling fox's nails. A native of New Zealand. A. lucidum is a native of the Falkland islands, introduced here in 1777 by Dr. Fothergill; it flowers in May and June.

ANDALUSITE, or *hardspar*, in mineralogy, a species of the Felspar family, dis-

covered by Bournon in a primitive granitic mountain in Forez. Colour flesh red, sometimes approaching to rose red. Massive, and crystallized in rectangular four-sided prisms. Specific gravity 3.16. Infusible by the blow-pipe without addition. It is distinguished from felspar by its great hardness, and higher specific gravity, and from corundum, by its inferior specific gravity and its form. It is now found in the primitive mountains in Spain and France, with quartz and mica, and sometimes in a mica state at Braunsdorf, near Freyberg in Saxony.

ANDRACHNE, in botany, a genus of the Monœcia Gynandria class of plants; the corolla of the male flower is formed of five emarginated slender petals, shorter than the cup; the female flower has no corolla; the fruit is a capsule containing three cells, with two obtuse trigonal seeds, roundish on one side, and angular on the other. There are three species.

ANDRÆA, in botany, a genus of the Cryptogamia Musci class and order. Essen. char. capsule very short, turbinate: fringe simple, of four incurved concave teeth, united at their tips, and bearing the lid and veil. There are two species.

ANDROIDES, in mechanics, an automaton, in the figure of a man, which, by virtue of certain springs, &c. duly contrived, walks and performs other external functions of a man. Albertus Magnus is recorded as having made a famous androides, which is said not only to have moved, but to have spoken. Thomas Aquinas is said to have been so frightened when he saw this head, that he broke it to pieces; upon which Albert exclaimed, "Periit opus triginta annorum." Artificial puppets, which, by internal springs, run upon a table, and, as they advance, move their heads, eyes, or hands, were common among the Greeks, and from thence they were brought to the Romans. Figures, or puppets, which appear to move of themselves, were formerly employed to work miracles; but this use is now superseded, and they serve only to display ingenuity, and to answer the purposes of amusement. One of the most celebrated figures of this kind was constructed and exhibited at Paris, in 1738; and a particular account of it was published in the Memoirs of the Academy for that year. This figure represents a flute-player, which was capable of performing various pieces of music, by wind issuing from its mouth into a German flute, the holes of which it opened and shut with its fingers: it was about 5½ feet high, placed upon a square pedestal 4½ feet high, and 3½ broad. The air entered the body by three separate pipes, into which it was conveyed by nine pairs of bellows, that expanded and contracted, in regular succession, by means of an axis of steel turned by clock-work. These bellows performed their functions without any noise, which might have discovered the manner by which the air was conveyed to the machine.

The three tubes which received the air from the bellows passed into three small reservoirs in the trunk of the figure. Here they united, and ascending towards the throat, formed the cavity of the mouth, which terminated in two small lips, adapted in some measure to perform their proper functions. Within this cavity was a small moveable tongue, which, by its motion at proper intervals, admitted the air, or intercepted it in its passage to the flute. The fingers, lips, and tongue, derived their proper movements from a steel cylinder, turned by clock-work. This was divided into fifteen equal parts, which, by means of pegs pressing upon the ends of fifteen different levers, caused the other extremities to ascend. Seven of these levers directed the fingers, having wires and chains fixed to their ascending extremities, which, being attached to the fingers, made them to ascend, in proportion as the other extremity was pressed down by the motion of the cylinder, and vice versa; then the ascent or descent of one end of a lever produced a similar ascent or descent in the corresponding fingers, by which one of the holes of the flute was occasionally opened or stopped, as it might have been by a living performer. Three of the levers served to regulate the ingress of the air, being so contrived as to open and shut, by means of valves, the three reservoirs above mentioned, so that more or less strength might be given, and a higher or lower note produced, as occasion required. The lips were, by a similar mechanism, directed by four levers, one of which opened them to give the air a freer passage, the other contracted them, the third drew them backward, and the fourth pushed them forward. The lips were projected upon that part of the flute which receives the air, and, by the different motions already mentioned, modified the tune in a proper manner. The remaining lever was employed in the direction of the tongue, which it easily moves, so as to shut or open the mouth of the flute. The just succession of the several motions, performed by the various parts of this machine, was regulated by the following simple contrivance. The extremity of the axis of the cylinder terminated

on the right side by an endless screw, consisting of twelve threads, each placed at the distance of a line and an half from the other. Above this screw was fixed a piece of copper, and in it a steel pivot, which, falling in between the threads of the screw, obliged the cylinder to follow the threads, and, instead of turning directly round, it was continually pushed to one side. Hence, if a lever was moved, by a peg placed on the cylinder, in any one revolution, it could not be moved by the same peg in the succeeding revolution, because the peg would be moved a line and a half beyond it by the lateral motion of the cylinder.

Thus, by an artificial disposition of these pegs in different parts of the cylinder, the statue was made, by the successive elevation of the proper levers, to exhibit all the different motions of a flute-player, to the admiration of every one who saw it. Another figure, constructed by the same artist, Vaucanson, played on the Provencal shepherd's pipe, held in its left hand, and with the right beat upon a drum.

The performances of Vaucanson were imitated, and even exceeded, by M. de Kempelin, of Presburg, in Hungary. The androides constructed by this gentleman, in 1760, was capable of playing chess. It was brought over to England in 1783, and remained here for more than a year. It is thus described: The figure is as large as life, in a Turkish dress, seated behind a table, with doors 3½ feet long, 2 deep, and 2½ high. The chair on which it sits is fixed to the table, which is made to run on four wheels. It leans its right arm on the table, and in its left hand holds a pipe; with this hand it plays after the pipe is removed. A chess-board of 18 inches is fixed before it. The table, or rather chest, contains wheels, levers, cylinders, and other pieces of mechanism, all of which are publicly displayed. The vestments of the figure were then lifted over its head, and the body seen full of similar wheels and levers. There is a little door in its thigh, which is likewise opened: and with this, and the table also open, and the figure uncovered, the whole is wheeled about the room. The doors are then shut, and the automaton is ready to play; and it always takes the first move. At every motion the wheels are heard, the image moves its head, and looks over every part of the chess-board. When it checks the queen it shakes its head twice, and thrice in giving check to the king. It likewise shakes its head when a false move is made, replaces the piece, and makes its own move, by which means the adversary loses one. M. de Kempelin exhibited his automaton at Petersburg, Vienna, Paris, and London, before thousands, many of whom were mathematicians, and chess-players, and yet the secret by which he governed the motion of its arm was never discovered. He valued himself upon the construction of a mechanism, by which the arm could perform ten or twelve moves. It then needed to be wound up like a watch, after which it was capable of continuing the same number of motions. This automaton could not play unless M. de Kempelin, or his assistant, was near it, to direct its movements. A small square box was frequently consulted by the exhibitor during the game, and in this consisted the secret, which the inventor declared he could communicate in a moment. Any person who could beat M. de Kempelin at chess, was sure of conquering the automaton.

Remark by the British Editor.—When this piece of mechanism was exhibited in London, it played a great number of moves without requiring to be wound up, and it was worked by a M. Anthon, who walked about the room, without any apparent communication, during the performance. The chess-board was part of the top of the square counter, or table, to which the figure was attached in a leaning posture. When the back of the figure was opened, an upright iron axis was seen, with two strong springs, which apparently were intended to restore the quiescent position after any move; and when the doors of the counter were opened, two compartments were seen, formed by an upright partition in the interior space. In one of them was seen a brass barrel, resembling that of a barrel organ, having sixteen verticle bars or levers, so placed as if to be tripped by the barrel; and there was also some wheel-work: and in the other compartment there was little, except a brass horizontal arc, or quadrant, with a brass radius, most probably capable of being set to different angular situations. The hand of the figure lay upon a cushion, and every approaching move was announced by the discharge of a click, and the buzzing noize of a fly was heard until the move was completed. The fore-arm was first raised about two inches by a vertical motion at the elbow: it was then carried horizontally, until the hand was immediately over the piece to be taken up, at which time the fingers suddenly opened, the hand dropped, seized the piece, rose again, made the move, and dropped the piece on the square to which it had arrived. But in case the adversary's piece were to be

taken, it was first seized in the manner here described, and carried clear off the board and dropped, and the subsequent move then made into the empty square. After the game was played, the Baron Kempelin gave the figure a knight, and it moved the piece in succession, without any pause, by the proper course, till it had passed every square in the board, as was shewn by an assistant placing a counter on each square, as the knight quitted it.

What can be deduced from so slight and transient a public view of this apparatus? —very little. It seems as if the greatest skill had been exerted in producing the mechanical effects, and that the communication of the player (Anthon) with the apparatus may be a riddle of no great depth. The sixteen pulls from the barrel may bear some relation to the eight rows of squares, twice taken for the two sides, the white and the black; and as the moves are all reducible to those of the castle of the bishop, from which they differ in extent of shift only, (except that of the knight, which is an immediate combination of both) we may guess that the pull might determine the line to be played in, and the quadrant the distance from the back row. But it is useless to extend our conjectures, with such scanty means.

The same Baron Kempelin exhibited, in his private parlour, a small speaking instrument or organ, which he said was not then in a finished state. It was a kind of box, which he brought out and placed upon a table. Speaking without notes from the recollection of four and twenty years now elapsed, I judge its dimensions were about two feet in length, one foot wide, and eight or nine inches deep. It was open; but we were prevented from seeing the inside by a cloth put over it. The Baron put his hands under the cloth, so that his right arm was disposed longitudinally in the box, and seemed to press a pair of bellows: the other hand was put in crosswise at the end, near the place of the right hand, and seemed to be employed with keys, or some apparatus, or perhaps both hands may have been so employed. When he made the instrument speak, he raised his right elbow, and gradually pressing it down, the sound was heard. It was monotonous, as if from a single pipe, about the pitch of D, above the middle C, concert pitch; and the words papa and mama were uttered very distinctly, in a slow drawling manner; that is to say, there was a want of the usual inflections of tone, and the sound fell off in intensity towards the end. After several other words had been spoken, a lady asked in French, if it could not speak sentences, and the Baron asked what it should say. She answered "*Que je suis mechante,*" and the instrument said "*Vous etes mechante, mais vous etes aussi bonne.*"

Kratzenstein has given some account of the principles of an engine of this kind, in a work extracted in the Journal de Physique: and Dr. Young has cursorily mentioned this subject in his lectures, with some diagrams.

ANDROMEDA, in astronomy, a small northern constellation, consisting of twenty-seven stars, visible to the naked eye, behind Pegasus, Cassiopica, and Perseus. The number of stars placed in this constellation by Ptolemy is 27; by Tycho Brahe 23; by Hevelius 47; and by Flamstead 66. The constellation has been thought to resemble a woman almost naked, with her feet at a distance from each other, and her arms extended and chained.

ANDROMEDA, in botany, a genus of the Decandria Monogynia class of plants; the calyx of which is a very small acute coloured and permanent perianthium, cut into five segments; the corolla consists of a single petal, of an oval form, inflated and quinquefid; the fruit is a roundish capsule, containing five cells, in which are several roundish shining seeds. There are 25 species.

ANDROPOGON, in botany, a genus of the Polygamia Monoecia class of plants, the calyx of which is a bivalve, oblong, obtuse glume; the corolla is also a bivalve glume, smaller and thinner than the cup; there is no pericarpium; the seed, which is single, oblong, covered and armed with the arista of the flower, is included in the glumes of the calyx and corolla. There are 32 species.

ANEMOMETER, among mechanical philosophers, an instrument contrived for measuring the strength of the wind. There are various kinds of anemometers; that of which Wolfius gives the structure is moved by sails like those of a windmill. He experienced, he says, the goodness of it, and affirms that the inward structure may be preserved to measure even the force of running water, or that of men and horses when they draw. In the memoirs of the academy of sciences is described a new anemometer, which expresses on paper, not only the several winds that have blown during the space of the last 24 hours, but also the strength and velocity of each. In the philosophical Transactions for the year 1766, Mr. Brice has described a method of measuring the velocity of the wind, by means of

that of the shadow of clouds passing over the surface of the earth. This, however, in general exceeds that near the ground. M. d'Ons en Bray invented an anemometer, which of itself expresses on paper, not only the several winds that have blown during the space of twenty-four hours, and at what hour each began and ended, but also the strength and velocity of each. See Memoirs Acad. Scien. Anno 1734.

ANEMONE, in botany, a genus of the Polyandria Polygynia class and order. Its characters are, that it has no calyx; that the corolla has petals in two or three rows, three in a row, somewhat oblong; the stamina have numerous filaments, capillary, half the length of the corolla: anthers, twin and erect: the pistillum has numerous germs on a head, styles acuminate, and stigmas obtuse: no pericarpium; receptacle globular or oblong; seeds very many, acuminate, retaining the style: there are about 30 species. The garden anemones are natives of the east, from whence their roots were originally brought; but culture has so improved them, that they are become the chief ornaments to our gardens in the spring. To prepare the soil for these plants, take a quantity of fresh, light, sandy loam, or hazel-earth, from a common or dry pasture, not dug above ten inches deep; mix this with a third part of its quantity of rotten cow-dung, and lay it up in a heap; turn this over at least once a month, for eight or ten months, and every time pick out the stones, and break the clods. After this mixture has been twelve months made, it will be fit for use. The beds of this earth must be prepared in September, and should be made six or eight inches deep, in a wet soil: but in a dry one, three inches will be sufficient; lay this compost at least 2½ feet thick, with about four or five inches of rotten neat's dung, or the rotten dung of an old melon or cucumber bed, at the bottom; in a wet soil let the beds be rounded, so that the water may run off; but in a dry soil let them be nearer to a level: three weeks after the compost has been laid in, stir it about six inches deep with a spade, and then with a stick draw lines each way of the bed, at six inches distance, so that the whole may be in squares; then make a hole three inches deep in the centre of each square, and plant a root in each; and when all are planted, rake the earth of the whole bed smooth, so as to cover the roots two inches thick. The season of planting these roots for forward flowers is the latter end of September; and for those of a middle season is October: this is best done at a time when there are gentle rains. Some roots should also be saved, to be planted after Christmas, for fear of accidents to the former from very hard weather. These usually flower three weeks after those planted in autumn. They are propagated two ways, either by dividing the roots or by sowing. The roots are to be divided as soon as they are taken up out of the ground; they will succeed, if broken into as many parts as there are eyes or buds in them; but they flower most strongly, if not parted too small. The way by sowing is this; choose first some good kinds of single anemones, called the gardeners poppy anemones; plant these early, and they will produce ripe seeds three weeks after the flower first blows. This must be carefully gathered, and in August it should be sowed in pots or tubs, or a well prepared bed of light earth, rubbing it between the hands with a little dry sand, to prevent several of the seeds from clinging together, and spreading them as even as possible all over the bed; after this a light hair brush should be drawn many times over the surface of the bed, to pull asunder any lumps of seed that may yet have fallen together; observing not to brush off the seed, and as much as possible not to brush it into lumps. When this is done, some light earth, about a quarter of an inch deep, should be sifted over the bed. If the weather be hot, the bed must be at times covered with mats laid hollow, and gently watered. In about ten weeks after sowing the plants will appear, if the season has been favourable, and they are to be carefully defended from the hard frosts by proper covering, and from the heat of the sun afterwards, by a moveable reed fence. As the spring advances, if the weather be dry, they must be gently watered, and when their green leaves decay, there must be a quarter of an inch more earth sifted over them, and the like again at Michaelmas; and the bed must be kept clear from weeds, and the following spring they will flower. The single or poppy anemones will flower most part of the winter and spring, when the seasons are favourable, and in a warm situation; and they require little culture, for it will be sufficient to take up the roots every other year; and when they are taken up, they should be planted again very early in the autumn, or else they will not flower till the spring. There are some fine blue colours among these single ane-

mones, which, with the scarlets and reds, form a beautiful mixture of colours; and as these begin to flower in January or February, when the weather is cold, they will continue for a long time in beauty, provided that the frost is not too severe. The seeds of these are ripe by the middle or end of May, and must be gathered daily as they ripen, because they will soon be blown away by the winds. The roots of wood anemone may be taken up when the leaves decay, and transplanted into wildernesses, where they will thrive, and in the spring have a good effect in covering the ground with their leaves and flowers. The blue anemone flowers at the same time with the foregoing, and intermixed with it, makes a fine variety. Double flowers of both these sorts have been obtained from seeds. This, and most of the other wild anemones, may be propagated by offsets from the root, which they put out plentifully; and they will grow in most soils and situations. Virginian anemone, and some others, produce plenty of seeds, and may be readily increased also that way.

ANEMOSCOPE, a machine invented to tell the changes of the wind. It should consist of an index moving about a circular plate, like the dial of a clock, on which the 32 points of the compass are drawn, instead of hours. The index, pointing to the divisions in the dial, is turned by an horizontal axis, having an handle-head at its outward extremity. This handle-head is moved by a cogwheel on a perpendicular axis, on the top of which is fixed a vane, that moves with the course of the wind, and gives motion to the whole machine. The contrivance is simple, the number of cogs in the wheel and rounds in the trundle-head must be equal, because it is necessary, that when the vane moves entirely round, the index of the dial should also make a complete revolution. A different anemoscope is described in the Phil. Trans. vol. xliii. part ii. and one is described in Martin's Phil. Brit. vol. ii.

ANETHUM, in botany, *dill*, a genus of the Pentandria Digynia class and order. Essen. char. fruit ovate, somewhat compressed, striate: petals involute, entire. There are three species. The common dill differs from fennel, in having an annual root, a smaller and lower stem; the leaves more glaucous, and of a less pleasant smell; the seeds broader and flatter. This plant grows wild among the corn in Spain and Portugal, and also near the coast in Italy, and near Constantinople: it is an annual, and has been cultivated here more than 200 years. The seeds are directed for use by the London and Edinburgh Pharmacopeias. Common fennel, another species of anethum, is much used for culinary purposes, and likewise in medicine.

ANEURISM, or ANEURYSM, in surgery, a throbbing tumour, distended with blood, and formed by a dilatation or rupture of an artery.

ANGEL, in commerce, the name of an ancient gold coin in England, of which some are still to be seen in the cabinets of the curious. It had its name from the figure of an angel represented upon it. It was $23\frac{3}{4}$ carats fine, and weighed four penny-weights. Its value differed in different reigns.

ANGELICA, in botany, a genus of the Pentandria Digynia class of plants, the general umbel of which is roundish and multiple; the partial umbel, while in flower, is perfectly globose; the general involucrum is composed of either three or five leaves; the partial involucrum is small, and composed of eight leaves; the proper perianthium is small and quinquedentate; the general corolla is uniform; the single flowers consist each of five deciduous, lanceolated, and slightly crooked petals; the fruit is naked, roundish, angular, and separable into two parts: the seeds are two, of an oval figure, plain on one side, and convex or striated on the other.

All the sorts may be increased by seeds. The common angelica delights in a moist soil, in which the seeds should be sown soon after they are ripe; and when the plants are about six inches high, they should be transplanted at a large distance, about three feet asunder, on the sides of ditches or pools of water. In the second year they will flower, and their stems may be cut down in May, and heads will be put out from the sides of the roots, and thus they may be continued for three or four years; but if they have been permitted to seed, their roots would perish soon after.—The stalks of garden angelica were formerly blanched, and eaten as celery. The young shoots are in great esteem among the Laplanders. In Norway, bread is sometimes made of the roots. The gardeners near London, who have ditches of of water in their gardens, propagate great quantities of this plant, which they sell to the confectioners, who make a sweetmeat with the tender stalks cut in May. Bohemia and Spain are supposed to produce the best: the College of London, formerly directed the roots brought from Spain only to be kept in the shops. Lin-

næus, however, assures us, that the plant proves most vigorous on its native northern mountains, and gives a decided preference to the root dug here, either early in the spring or late in the autumn. The roots of angelica are one of the principal aromatics of European growth, though not much regarded in the present practice. They have a fragrant agreeable smell, and a bitterish pungent taste; on being chewed they are first sweetish, afterwards acrid, and leave a glowing heat in the mouth and fauces, which continue for some time. The stalk, leaves, and seeds, appear to possess the same qualities, though in an inferior degree. Dr. Lewis says, that on wounding the fresh root early in the spring, it yields, from the inner part of the bark, an unctuous, yellowish, odorous juice, which, gently exsiccated, retains its fragrance, and proves an elegant, aromatic, gummy, resin. Rectified spirit extracts the whole of the virtues of the root; water but very little; and, in distillation with the latter, a small portion of very pungent essential oil may be obtained. The Laplanders extol the utility of angelica, not only as food but as medicine. For coughs, hoarseness, and other disorders of the breast, they eat the stalks, roasted in hot ashes; they also boil the tender flowers in dairy milk, till it attains the consistence of an extract; and they use this to promote perspiration in catarrhal fevers, and to strengthen the stomach in diarrhæa, &c. According to the explanations of Sir John Pringle, the herb is antiseptic, but the efficacy of the leaves is soon lost by drying them. The seeds also, which come nearest to the roots, can scarce be kept till the spring after they are gathered, without the loss of their vegetative power, as well as a diminution of their medicinal virtue. These are the only parts of the plant which are ordered by the London College, and that only in compound spirit of aniseed. The aromatic quality of the root is more considerable than that of any other part; but many other simples surpass angelica in aromatic and carminative powers; it is seldom employed in the present practice. All the parts of the wild angelica are similar in quality to those of the former species, but rather weaker, and the former may be more easily procured. Cows, goats, and swine, eat it, but horses refuse it.

ANGIOPTERIS, in botany, a genus of the Cryptogamia Filices. Essen. char. fructification oval, sessile, in a line near the margin of the frond, approximate in a double row, one celled.

ANGIOSPERMA, in botany, a term used, by Linnæus, to express the second order of the Didynamiæ plants, which have seeds not lodged naked within the cup, as in Gymnospermia, but inclosed in a capsule, and adhering to a receptacle in the middle of a pericarp. The class of Didynamia contains the labiated and personated plants. The Angiospermia are the personated; the others the labiated kind. In this order many of the corollas are personate, or labiate, with lips closed; some, however, have bell-shaped, wheel-shaped, or triangular corollas. To have seeds inclosed in a pericarp is common to all; and hence the name of the order Angiospermia. This order contains 87 genera.

ANGLE, in geometry, the inclination of two lines meeting one another in a point, and called the legs of the angle. See GEOMETRY.

ANGLING, may be defined the art of catching fish by a rod and line, furnished with a hook and bait, or artificial fly. It is divided into two species principally, fly fishing and bait fishing: the first is performed by the use of artificial flies, which are made to imitate natural flies so exactly, that fish take them with equal eagerness. The second species of angling is effected by the application to the hook of a variety of worms, grubs, small fish, parts of fish, and a number of other matters, which shall be detailed more particularly.

Fly fishing requires more skill and address than bait fishing; and the formation of the artificial flies, for it is an art in itself of so much nicety, that to give any just idea of it, we must devote an article to it particularly. See FISHING FLIES.

To constitute a good angler, a knowledge of the natural history of the fish he desires to take is essentially necessary: without this, he cannot perfectly know the bait most suitable to them at different seasons, and in different situations; which is so far from being obvious, that there are many small rivers which are considered as totally exhausted of their fish, by the generality of anglers, where, however, a few of extraordinary skill will find good sport, and take many fish of the best kinds.

The fish caught by angling in this part of the world are, the salmon, salmon-trout, cod, bull-head, flounder, weak-fish, sea-basse, black-fish, perch, rock, drum, cat-fish, eel, red drum, &c.

Several of these only inhabit the salt waters, others migrate regularly from the sea up the rivers to deposit their eggs, and some are found in the fresh waters only. In the lakes, rivers, and other streams of the interior, are caught rock, perch of different kinds, a salmon trout, gudgeon, carp, chub, roach, redfin, sucker, minnow

(called minny), white and yellow-bellied catfish, eel, sunfish, or old wife, pike, &c. &c. The common and silver minnow, on account of their diminutive size, are used only as bait.

To this list a very large addition might be made, but it would consist of names, like several of the above, often local, and confined exclusively to a particular state or district, or applied, in different parts of the country, to fish in every respect unlike each other. This vague nomenclature is a source of constant error, and obviously indicates the convenience, and even necessity, of an universal language, such as scientific natural history presents us with.

Baits for fish are principally natural; a few artificial ones are used, chiefly in fishing for pike and perch, made to imitate small fish, frogs, &c. The natural baits are whatever is commonly eaten by fish, as worms, maggots, grubs, caterpillars, snails, small fish, frogs, roe of fish, beetles, butterflies, moths, wasps, grasshoppers. Vegetable baits are sometimes used, as beans, wheat, barley, and peas, which last are best when green, and slightly boiled; paste made of dough, bread, or flour, mixed with oil, and a little cotton to unite it together, also forms bait. It is generally best to colour it red, particularly for smelts.

Maggots are best procured by hanging up a bullock's liver, scarified pretty deeply all over, covered loosely, so as to admit flies. In two or three days, living maggots will appear on it, when it should be taken down and put into a pan, till the gentles attain their full size; a sufficient quantity of fine sand and bran is then to be put over the liver in the pan; and the maggots will in a few days come into it and scour themselves, which renders them tough, clean, and fit to be handled. Those produced in autumn will continue in that state all the winter, if they can get just under the surface of the earth. In the spring, as the weather becomes warm, they change into flies.

The cadbate is a very excellent bait. This is an imperfect insect, resembling a worm, inclosed in a tube formed of agglutinated pebbles, out of which the head and six feet are protruded when in motion; it is the larva of the genus Phryganea, and is to be found in great plenty in gravelly and stony rivulets; and by the side of streams in large rivers among stones; when you want them, turn up the stones, and you will find the best sticking to them. When a sufficient quantity of them are procured, hang them up in a linen bag, and dip them, in the bag, once a day into water, for four or five days. They will then turn yellow, and become tough and fit for use, being much better than when they first came out of the water.

The lob, or dew worm, is found in gardens and pastures, late in summer evenings, by using a lanthorn and candle. They are also dug up in fields, and by the sides of drains and ditches. To scour and preserve them for use, take some moss, dip it into clean water, wring it dry, put half of it into an earthen pot, then put in the worms, and the rest of the moss at top; cover it close, that they may not get out, and keep it in a cool place in summer, and in a warmer in winter; the moss should be changed every fifth or sixth day. In a week the worms will be fit for use. These directions will also answer for other species of worms.

Brandlings, red-worms, and gilt-heads, are found in the same dunghills together, which consists of hogs' dung, horses' dung, and rotten earth. But the worms which are found in tanner's bark, after it has been used and become quite rotten, are the best of all; but they are generally better for angling without any scouring.

Long white worms, found chiefly in turnip fields, are good bait, especially in muddy water. They are preserved best in some of their own earth, kept damp, with some moss over it.

Marsh worms, found in marshy grounds and rich banks of rivers.

The red worms, found in cow dung, and dock worms, found about the roots of docks, flags, and sedges, are all good bait. As are likewise the grubs found in cow dung, called cow-dung bobs, which are of a yellowish white, with red heads, and the short bobs, or grubs, found in mellow sandy land, which have pale red heads, yellowish tails, and bodies of the colour of the earth wherein they are found, but which when scoured are of a pale white. These last are an excellent winter bait; the best way to render them tough is, to put them into boiling milk, for about two minutes, on the morning which they are to be used.

Caterpillars, found by beating the branches of oaks, and other trees, that grow over highways, paths, and open places, and the cabbage grubs found on and in the hearts of cabbages, are also excellent bait; these last are to be fed, and preserved, with the same kind of leaves on which they are found. Shad-roe is likewise a good bait; but the numerous pastes

and oils, which many have prescribed for enticing fish to bite, are, in the opinion of the most experienced anglers, only idle chimæras.

Worms are best put on hooks, by running the hooks in at the head of one worm, and out about his middle, drawing it up over the shank, and putting on a second worm beneath the first, in the middle of whose body the point of the hook is to be concealed; the tails of both worms hanging loose will entice the fish.

Ground bait is often used with good effect, particularly for barbel and for perch. It should be a general rule, that the ground bait should be always inferior to that which is used on the hook; greaves therefore should not be used, as is customary with some; but for this purpose, malt grains, bran, blood, parts of lobworms, and clay, all worked up together and made into small balls, is the most proper composition; and two or three of these balls, thrown into the place where you desire to fish, is sufficient at a time. This may be repeated now and then, but much should not be used, for if this should be done, the fish will glut themselves, and become less eager for the bait on the hook.

A good ground bait is made for perch, by taking three or four balls of the stiffest clay that can be procured, making holes in them, putting one end of a lob-worm into each hole, and closing the clay fast on them. These balls should then be thrown into the water, about a yard from each other, when the worms, being alive in the balls, will move and twist about, which tempts the fish to feed upon them. But by angling with worms of a superior kind, the fish will on sight of them leave those in the clay, and seize the others with the greatest avidity.

The tackle necessary for angling consists of fishing rods, lines, links of hair, and of other materials usual; hooks, floats, spare-caps, split shot, bait of different sorts, including ground bait, shoemakers' wax, twine, silk, a clearing ring, which being passed over the rod, when the hook is entangled, and drawn down the line by a strong twine attached to it for the purpose, to the hook or below it, if the obstruction is caused by weeds, will either free the hook or break the line near it, and prevent its being strained in any other place, by pulling the twine with sufficient force. A landing net is also useful to land large fish: and a gaff, when fishing for salmon, to be used for the same purpose; which instrument consists of a large hook attached to the end of a pliable stick; by passing the hook into the nose or gills of the fish, it may be easily lifted out of the water, for which purpose a landing net is too small. A disgorger is also necessary, to put down the throat of a fish, when he has gorged the hook, till you touch it, when on pulling the line it will be free. The disgorger is formed by a piece of flat wood, about six inches long, and half an inch wide, forked at the ends. To these articles a fish-basket should be added, to carry the fish in.

Fishing rods are made of various lengths, according to the sort of fish they are intended for; those for salmon are about 18 feet long, those for trout 14 or 15 feet, those for pike the same as for salmon; and for other fish, either the trout or the salmon, rods may be used according to their size and strength. All rods should be made to taper evenly from the buts; and when not formed of pieces of the natural growth, which should always consist of ground shoots, they should be made of cleft timber, as sawed pieces can never be depended on. Ash, or hickory are best for the lower joints, yew for the next, and the extremity of the top should always consist of whalebone; the fewer joints used in the rod the more equal will be its elasticity in every part; some have the joints formed with screw ferules, and some with sliding connections retained by plain ferules; but none are better for the elasticity of the rod, and for security, than simple spliced joints, secured by well waxed twine; some recommend those latter joints to be previously glued together, before the waxed twine is applied, with glue prepared with strong lime water: but it is obvious that the wet to which rods are exposed must render glue of little use: thick white paint, or some of the varnish hereafter mentioned, would probably cement the pieces together more durably. Whatever may be the number of permanent joints, the long rods need not be made to separate into more than three long pieces, and a short top; and the short rods into two pieces, and a short top; the lower joint of trout rods should be bored hollow, to contain a second top; for every trout rod should have two tops made for it; one very pliable for fly fishing, and the other stiffer for bait; the top not in use will be conveniently and safely kept in the hollow but. The rod should be furnished with rings for the line to pass through, from the top to within two feet of the

reel; and when it is completed, it should be well varnished over with a varnish formed by boiling a little scraped Indian rubber, or coutchouc, in half a pint of drying linseed oil till it dissolves; the varnish should be skimmed, and be used warm. The rod, after being varnished, should be laid aside till quite dry; the varnish will then appear on it like a fine thin bark, will be very durable, and will preserve it from being worm eaten, and from other injuries. The hollow part of the rod should be rubbed inside with linseed oil, three or four times each year, which may be done by a rag dipped in the oil, and tied to the end of a stick.

Hair lines should be long, round, clear, and free from knots, frets, or scales. For fly fishing, a line should be prepared from nine to twelve yards long, gradually tapering to the extremity. It is formed of a number of links of hair, twisted first, and then knotted to each other. The four lowest links consist of three hairs each, with the weak tops cut off all of a length; the next four links have four hairs each; the third four links five hairs; and so on till the line is completed. The links are to be knotted together with the fisherman's or water-knot; the short ends of the hairs are to be cut off pretty close to the knots, and the knots to be whipped over with well-waxed silk. A loop should be made at each end of this line: the upper loop to fasten it to the end of the running line at the top of the rod, and the lower loop to fasten the lower links to, which should never consist of more than two or three, of either gut or hair, for fly or bottom fishing.

The best colours for lines are pale bluish, green, or watery grey, and light bay.

Running hair lines, or those all of one thickness, are made on engines prepared and sold at the fishing-tackle shops. They may likewise be made by passing hairs through three short tubes made of quills or reeds, secured by pegs at the lower ends. The hairs are to be knotted together at the top, and the quills being then turned round all together between the fingers, will form an equal twist above them; which being drawn out, according as the quills are turned round, make the line, fresh hairs being still put into the quills at the lower ends as the upper hairs are worked into the line.

The most excellent hooks are those made of the best tempered fine steel wire, longish in the shanks, and strong and rather deepish in the bend; the barbs well formed, and the point fine and straight, and as true as it can be set to be level with the shank, which last for fly fishing should be tapered off to the end of it, that the fly may be finished the neater. Hooks made in this manner, so as to lie all in one plane, are much better than twisted so as to project at one side: they do not make so large an orifice when the fish is hooked, nor are they so liable to break the hold as the others. The two kinds being fairly tried against each other for several seasons, considerably more fish were missed in the rising, and in biting at the bottom, and much more lost after being hooked with the crooked hooks, than with those above recommended. The best hooks of the kind are made in Limerick.

Floats for angling are made of many kinds, as of swan quills, goose quills, Muscovy duck quills, and porcupine quills. The first is the best, when light baits are used in rivers or deep waters, and the others for slow water, or ponds not very deep. For heavy fishing, with worms or minnows, a cork float is best, made of a pyramidical form, with a quill placed in it lengthways for the line to pass through. Quill floats must carry shot enough to sink them, so as that the top may appear above water, that the slightest nibble may be better perceived. The cork floats should have sufficient shot placed beneath them on the line, to make them stand upright when the shot is off the bottom, by which it may be known when the shot is on the ground; for then the float will fall on one side, and no longer stand upright.

Angling has been divided, by those who have written on the subject, into many other kinds besides those mentioned. Of these, float angling and ground angling may be easily understood from what has been mentioned already. Night angling is performed nearly in the same way as day angling; but in it the larger and more conspicuous bait, such as garden worms, snails, and minnows, are best. Some lay long lines in rivers at night, with short lines, furnished with hooks attached to them at certain intervals; and some use lines fastened to floats of various sorts; but these modes of fishing can scarcely be called angling, properly speaking. The largest and finest fish are often caught by these methods.

Sea angling has nothing particular in it, but that small parts of fish, clams or crabs, are mostly used in it for bait. The same fish may be caught at the heads of piers and the mouths of rivers, and by the same bait as at sea, therefore fishing in such places is classed with sea angling.

Lastly, trimmer angling is a species of

float angling. The float consists of a round piece of cork, six inches in diameter, with a groove cut at its edge, in which the line is coiled, except so much next the hook as to allow it to hang in mid-water, and so much at the other end as will reach to the bank. When a fish takes the bait, and runs with it, the line unwinds off the trimmer without giving any check; but it will be prudent to give a slight jerk, to secure the fish when you come to take up the line. This method is very successful in canals, large ponds, or other still water.

Before concluding this article it will be proper to notice, that the weather has much influence on fish. When the wind is in some points few fish will bite; the most unfavourable is the eastern quarter. A warm lowering day, with flying showers, and a slight ripple on the water, is the most favourable. Water slightly disturbed prevents fish from seeing the tackle, and in it they take the bait most readily. Hence, whatever tends to disturb it so as to hide the line, without totally obscuring the bait, is of advantage. In waters affected by the tide, the flood is the best time for angling; but the ebb should not be neglected. Whirlpools, eddies, mill-tails, sides of bridges, and beneath their arches, are places where fish more readily bite, chiefly for the above reason; and in general a certain degree of darkness in the water, whether occasioned by the shade of buildings, rocks, or other bodies, or caused by the agitation of its surface, or by muddy streams flowing into it, is favourable to angling.

The proper season for fishing is in general from the beginning of spring to the end of autumn; but this depends much on the nature of the fish angled for: some may be caught at all times; others, as those of passage, are only to be met with at particular seasons; and others, though always confined to one piece of water, are nearly torpid during the winter, and are found only in deep places.—See Taylor's Angling.

ANGUIS, in natural history, the *slow-worm*, a genus of serpents: the generic character is, scales both on the abdomen and beneath the tail. There are, according to Gmelin, 26 species. This genus is easily distinguished, by having the abdomen and under part of the tail covered with scales of a similar appearance to those on the rest of the animal, except that in some few instances they are rather larger. The body is of a shorter and more uniformly cylindric form than in the genus Coluber: the eyes are in general small, and the tail rather obtuse. No poisonous species of anguis has yet been discovered. A. fragilis, or common slow-worm, is found in almost all parts of Europe, in similar situations with the common snake, and is a perfectly innoxious animal, living on worms and insects. It is about 10 or 12 inches long: the tail measures more than half the length of the animal, and terminates pretty suddenly in a slightly acuminated tip. The slow-worm is a viviparous animal, and produces occasionally a numerous offspring: like other serpents, it varies in intensity of colours at different periods, and the young are commonly of a deeper cast than the parent animal. The general motions of the slow-worm are tardy, except when endeavouring to make its escape: it can, however, occasionally exert a considerable degree of swiftness, and can readily penetrate the loose soil in order to conceal itself from pursuit. They are often found in considerable numbers during winter, at some depth beneath the surface, and lying in a state of torpidity, and again emerging from their concealments on the approach of spring, when they cast their skin, and recover their former liveliness. If struck with violence, the body of this animal will break into pieces. A. corallina, or coral slow-worm, is a very elegant species, about 18 inches long, and of a considerable thickness: the scales are moderately large, and the head and tail are remarkably obtuse. It is a native of South-America, where it is found in woods, and to prey on the larger insects, as the scolopendræ, &c.: in colour it sometimes varies, a mixture of black being blended with the red on the sides. (See Plate I. Serpentes, fig. 3.) A. ventralis, or glass slow-worm, is a handsome species, about two feet long: it is a native of North-America; body ashy-green, striate; lateral band black; belly short, apparently joined by a hollow suture; tail verticillate, three times as long as the body; it takes its name from the circumstance of breaking to pieces in two or three places with a small blow of a stick, the muscles being articulated quite through the vertebræ. A. Jamaicensis, or Jamaica slow-worm, found in Jamaica about the roots of decayed trees, near ants' nests, &c. and though it has generally been deemed poisonous, yet it is really innocuous; its colour is an uniform pale brown, with a kind of silvery gloss on the scales, which are very smooth.

ANGULAR *motion*, in mechanics and astronomy, is a motion of a body which describes an angle, or which moves circularly round a point. Thus a pendulum has an angular motion about its centre of

motion, and the planets have an angular motion about the sun. The angular motions of revolving bodies, as of the planets about the sun, are reciprocally proportional to their periodic times; and they are also as their real or absolute motions directly, and as their radii of motion inversely.

Angular motion is also composed of a right-lined and circular motion, or in which the moveable body slides and revolves at the same time: such is the motion of a coach-wheel.

ANGURIA, in botany, a genus of the Monoecia Diandria class and order; calyx five-cleft; corolla five-petalled; pome inferior, two-celled, many-seeded.

ANHYDRILE, in mineralogy, one of the sulphate family, found at Salz on the Neckar, in Wirtemberg. Colour smalt blue, which passes into a milk white. Massive: not very brittle. Specific gravity 2.94. It differs from cube spar in colour, fracture, shape of fragments, and in having a higher specific gravity.

ANIGOZANTHUS, in botany, a genus of the Hexandria Monogynia class and order: corolla six parted, with unequal incurved segments: staminainserted in the throat of the corolla: capsule three-celled, many-seeded. There is only a single species; a native of New Holland. The stem is leafy, covered at the top with reddish hairs, leaves linear: flowers umbelled: corolla clothed with reddish hairs.

ANIMAL, in natural history, an organised and living body, endowed with the powers of sensation, and of spontaneous loco-motion. Some have defined animals, from their loco-motion, as being capable of shifting from place to place, whereas plants adhere to the same subject. This property they assume, as the great characteristic by which animals may be distinguished from the other orders of beings. On this principle, however, oysters, barnacles, and many zoophytes, would be almost excluded from the class of animals, inasmuch as they usually adhere or grow to rocks, &c. and yet it is certain that these creatures are real animals. But loco-motion alone is not sufficient to constitute the generic difference of animals; nor, indeed, does it sufficiently distinguish an animal from a plant. Many instances are produced in which plants manifest loco-motive power. This is the case with those denominated sensitive plants, many of which, upon the slightest touch, shrink back and fold up their leaves; as the snail in the slightest touch retires into its shell. There are some, on which if a fly perches, instantly close and crush the insect to death. Plants also change their position and form in different circumstances and seasons: they take advantage of good weather, and guard themselves against bad weather; they open their leaves and flowers in the day, and close them at night; some close before sun-set, and some after; some open to receive rain, and some close to avoid it; some follow the sun, and some turn from it; the leaves of some plants are in constant motion during the day, and at night they sink to a kind of rest or sleep. It has also been observed, that a plant has a power of directing its roots for procuring food; and that it has a faculty of recovering its natural position after it has been forced from it. A hop-plant, for instance, in twisting round a pole, directs its course from south to west, as the sun does; if it be tied in the opposite direction it dies; but if it be left loose in this direction, it will regain its natural course in a single night. A honeysuckle proceeds in a certain direction, till it be too long to sustain itself; it then acquires strength by shooting into a spiral form; and if it meet with another plant of the same kind, both these coalesce for mutual support, one twisting to the right and the other to the left. There are other instances in which plants manifest a faculty of loco-motion; and, perhaps, in almost as eminent a degree as some animals. Oysters, *e. g.* are fixed to one place as much as plants, nor have they any power of motion, besides that of opening and shutting their shells; nor do they seem, in this respect, to have any superiority, with regard to the powers of motion, to the sensitive plant, and others of a similar kind. In order, therefore, to form a complete and satisfactory distinction between animals and vegetables, as well as minerals, it is necessary to combine with spontaneous loco-motion, which they unquestionably possess in a more perfect degree than plants, the powers of sensation. These seem to be unexceptionably distinguishing and characteristic. However, M. Buffon, after allowing that, although progressive motion constitute a perceptible difference between an animal and a vegetable, this distinction is neither general nor essential, proceeds to state, that sensation more essentially distinguishes animals from vegetables. But he adds, that this distinction is neither sufficiently general nor decided. If sensation, he says, implied no more than motion consequent upon a stroke or impulse, the sensitive

plant enjoys this power; whereas, if by sensation we mean the faculty of perceiving, and of comparing ideas, it is uncertain whether brute animals are endowed with this faculty. If it should be allowed to dogs, elephants, &c. whose actions seem to proceed from motives similar to those by which men are actuated, it must be denied to many species of animals, particularly to those that appear not to possess the faculty of progressive motion. If the sensation of an oyster, *e. g.* differ in degree only from that of a dog, why do we not ascribe the same sensation to vegetables, though in a degree still inferior? In examining the distinction which arises from the manner of feeding, he observes, that animals have organs of apprehension, by which they lay hold of their food: they search for pasture, and have a choice in their aliment. But, it is alleged, that plants are under the necessity of receiving such nourishment as the soil affords them, without exerting any choice in the species of their food, or in the manner of acquiring it. However, if we attend to the organization and action of the roots and leaves, we shall soon be convinced that these are the external organs, by which vegetables are enabled to extract their food; that the roots turn aside from a vein of bad earth, or from any obstacle which they meet with in search of a better soil; and that they split and separate their fibres in different directions, and even change their form, in order to procure nourishment to the plant. From this investigation, he concludes that there is no absolute and essential distinction between the animal and vegetable kingdoms; but that nature proceeds by imperceptible degrees, from the most perfect to the most imperfect animal, and from that to the vegetable; and that the fresh water polypus may be regarded as the last of animals, and the first of plants. After examining the distinctions, this author proceeds to state the resemblances which take place between animals and vegetables. The power of reproduction, he says, is common to the two kingdoms, and is an analogy both universal and essential. A second resemblance may be derived from the expansion of their parts, which is likewise a common property, for vegetables grow as well as animals; and though some difference in the manner of expansion may be remarked, it is neither general nor essential. A third resemblance results from the manner of their propagation. Some animals, he says, are propagated in the same manner, and by the same means, as vegetables. The multiplication of the sacceron or vine-fritter, (see Aphis) which is, he observes, effected without copulation, is similar to that of plants by seed; and the multiplication of the polypus by cuttings resembles that of plants by slips. Hence it is inferred that animals and vegetables are beings of the same order, and that nature passes from the one to the other by imperceptible degrees; since the properties in which they resemble one another are universal and essential; while those by which they are distinguished are limited and partial. Dr. Watson, Bishop of Landaff, has examined, with his usual judgment, the distinguishing marks between animals and vegetables. He rejects, as insufficient, both figure and spontaneous motion; and if perception be substituted in their stead, it will be found to be a criterion that is, in many respects, liable to exceptions. However, the ingenious and learned prelate produces many chemical, physical, and metaphysical reasons, which serve to render the supposition not altogether indefensible, that vegetables are endowed with the faculty of perception. Dr. Percival, likewise, in a paper read before the Literary and Philosophical Society of Manchester, produces several arguments to evince the perceptive power of vegetables. From the reasoning adduced by both these ingenious writers, of which a more particular account will be given in the sequel of this work (see Plants and Vegetables); those who duly advert to it will, we conceive, incline to the opinion, that plants are not altogether destitute of perception. But on a question that has perplexed and divided the most ingenious and inquisitive naturalists, it is very difficult to decide. If we extend to the vegetable kingdom that kind of vitality with which sensation and enjoyment are connected, there will remain no discernible boundary between this and the animal kingdom; and that which has been considered as the distinctive characteristic of animals, and by which they are separated from vegetables, will be abolished. We shall now add, that the principle of self-preservation belongs to all animals; and it has been argued, that this principle is the true characteristic of animal life, and that it is unquestionably a consequence of sensation. There is no animal, when apprehensive of danger, that does not put itself into a posture of defence. A muscle, when it is touched, immediately shuts its shell; and as this

action puts it into a state of defence, it is ascribed to a principle of self-preservation. Those who adopt this reasoning allege that vegetables do not manifest this principle. When the sensitive plant, for instance, contracts from a touch, it is no more in a state of defence than before, for whatever would have destroyed it in its expanded state, will also destroy it in its contracted state. They add, that the motion of the sensitive plant proceeds only from a certain property called irritability; and which, though possessed by our bodies in an eminent degree, is a characteristic neither of animal or vegetable life, but belongs to us in common with brute matter. The sensitive plant, after it has contracted, will suffer itself to be cut in pieces, without making the least effort to escape. This is not the case with the meanest animal. An hedgehog, when alarmed, draws its body together, and expands its prickles, thus putting itself in a posture of defence: when thrown into the water, the same principle of self-preservation prompts it to expand its body and swim. A snail, when touched, withdraws itself into its shell; but if a little quick-lime be sprinkled upon it so that its shell is no longer a place of safety, it is thrown into agonies, and endeavours to avail itself of its loco-motive power, in order to escape that danger. Muscles and oysters, also, though they have not the power of progressive motion, constantly use the means which nature has given them for self-preservation. We, ourselves, possess both the animal and vegetable life, and ought to know whether there be any connection between vegetation and sensation, or not. We are conscious that we exist, that we hear, see, &c. but of our vegetation we are absolutely unconscious. We feel a pleasure in gratifying the demands of hunger and thirst; but we are totally ignorant of the process by which our aliment is formed into chyle, the chyle mixed with the blood, the circulation of that fluid, and the separation of all the humours from it. If we, then, who are more perfect than other vegetables, are utterly insensible of our own vegetable life, why should we imagine that the less perfect vegetables are sensible of it? We have within ourselves a demonstration, that vegetable life acts without knowing what it does; and if vegetables are ignorant of their most sagacious actions, why should we suppose that they have any sensation of their inferior ones; such as contracting from a touch, turning towards the sun, or advancing to a pole? As to that power of irritability which is observed in some plants, our solids have it, when deprived both of animal and vegetable life; for a muscle, cut out of a living body, will continue to contract, if it be irritated by pricking, after it has neither sensation nor vegetation. Encycl. Brit. On the other hand, those who are of opinion that plants possess powers of perception, allege that their hypothesis recommends itself by its consonance to those higher analogies of nature, which lead us to conclude that the greatest possible sum of happiness exists in the universe. The bottom of the ocean is overspread with plants of the most luxuriant magnitude; and immense regions of the earth are overspread with perennial forests. Nor are the Alps or the Andes destitute of herbage, though buried in depths of snow; and can it be imagined that such profusion of life subsists without the least sensation or enjoyment? Let us rather, with humble reverence, suppose that vegetables participate, in some low degree, of the common allotment of vitality; and that one great Creator hath appointed good to all living things, in number, weight, and measure.

Animal *flower*, a name given to a variety of creatures of the Vermes tribe, that bear some resemblance to a flower. These, for the most part, belong to the order Molluscæ; the name is, however, frequently given to a different order, *viz.* the Zoophytes.

Animal *manures*, in agriculture, are all substances that are formed from the decomposition of animal substances of any kind; as the muscles, blood, hair, wool, bones, fat, &c. These are generally esteemed as more powerful, in promoting vegetation, than such as are derived from vegetable matters. On account, however, of their being but seldom procured in large quantities, they are generally made use of in the state of mixture or combination with other materials. By the action of ammonia, which is constantly formed during the decomposition of animal substances, the mould is made more suitable for plants.

Animal, *parts of*, substances which compose the bodies of animals may be arranged under the following heads:

1. Bones and Shells
2. Horns and Nails
3. Muscles
4. Skin
5. Membranes
6. Tendons and ligaments

7. Glands
8. Brain and nerves
9. Hair and feathers
10. Silk and similar bodies.

Besides these substances, which constitute the solid part of the bodies of animals, there are a number of fluids, the most important of which is the blood, which pervades every part of the system in all the larger animals: the rest are known by the name of secretions, because they are formed, or secreted, as the anatomists term it, from the blood. The principal animal secretions are the following:

1. Milk
2. Eggs
3. Saliva
4. Pancreatic juice
5. Bile
6. Cerumen
7. Tears
8. Liquor of the pericardium
9. Humours of the eye
10. Mucus of the nose, &c.
11. Sinovia
12. Semen
13. Liquor of the amnios
14. Poisonous secretions.

Various substances are separated either from the blood or the food, on purpose to be afterwards thrown out of the body as useless or hurtful. These are called excretions. The most important of them are,

1. Urine
2. Fæces.

Besides the liquids which are secreted for the different purposes of healthy animals, there are others which make their appearance only during disease, and which may therefore be called morbid secretions. The most important of these are the following:

1. Pus
2. The liquor of dropsy
3. The liquor of blisters.

To these we must add several solid bodies, which are occasionally formed in different cavities, in consequence of the diseased action of the parts. They may be called morbid concretions. The most remarkable of them are the following:

1. Salivary calculi
2. Concretions in the lungs, liver, brain, &c.
3. Intestinal calculi
4. Biliary calculi
5. Urinary calculi
6. Gouty calculi.

Animal *substances*, or those which have hitherto been detected in the animal kingdom, and of which the different parts of animals, as far as these have been analysed, are found to be composed, may be arranged under the following heads:

1. Gelatine
2. Albumen
3. Mucus
4. Fibrin
5. Urea
6. Saccharine matter
7. Oils
8. Resins
9. Sulphur
10. Phosphorus
11. Acids
12. Alkalies
13. Earths
14. Metals.

See the several articles in their alphabetical order.

Animal, *functions of.* See Assimilation, Digestion, Perspiration, Respiration, &c.

Animals, *generation of.* See the article Generation.

Animals, in heraldry, are much used, both as bearings and supporters. It is to be observed, that in blazoning, animals must be interpreted in the best sense, and so as to redound to the greatest honour of the bearers. For example, the fox being renowned for wit, and likewise given to filching for his prey; if this be the charge of an escutcheon, we must conceive the quality represented to be his wit, and not his theft. All beasts must be figured in their most noble action; as a lion rampant, a leopard or wolf passant, a horse running or vaulting, a greyhound coursing, a deer tripping, and a lamb going with a smooth pace. In like manner, every animal must be moving and looking to the right side of the shield, the right foot being placed foremost. These are the precepts given by Guillim, and yet we find that there are lions passant, couchant, and dormant, as well as rampant.

ANIMALCULE, an animal so minute in its size, as not to be the immediate object of our senses.

Animalcules are usually divided into two distinct sections, visible, and microscopical. The first, though visible, cannot be accurately discerned without the help of glasses: the second are discover-

able only by the microscope. Some have supposed there are others invisible. The existence of these cannot well be disputed, though it cannot be asserted, unless we conclude that the microscope has not yet arrived at its highest degree of perfection. Reason and analogy give some support to the conjectures of naturalists in this respect: animalcules are discerned of various sizes, from those which are visible to the naked eye, to such as appear only like moving points under the microscopic lenses of the greatest powers; and it is not unreasonable to imagine, therefore, that there are others, which may still resist the action of the microscope, as the fixed stars do that of the telescope, with the greatest powers hitherto invented.

Animalcules, visible; amongst these are included an amazing variety of creatures, by no means of analogous natures. Those numerous creatures which crowd the water in the summer months, changing it sometimes of a deep or pale red colour, green, yellow, &c. are of this description. The large kinds are chiefly of the insect, or vermes tribes, and of which the monoculus pulex is particularly remarkable, being found sometimes in such abundance, as to change the water apparently to a deep red. A similar appearance is likewise occasioned by the circaria mutabilis, when it varies in colour from green to red; vorticella fasciculata also changes it to green; and rotatoria to yellow. To this section we must also refer many of the acarus and hydrachna genera, and a multitude of other creatures that will be noticed hereafter.

Animalcules, microscopical. The microscope discovers legions of animalcules in most liquors, as water, vinegar, beer, dew, &c. They are also found in rain and several chalybeate waters, and in infusions of both animal and vegetable substances, as the seminal fluids of animals, pepper, oats, wheat, and other grain, tea, &c. &c. The contemplation of animalcules has made the ideas of infinitely small bodies extremely familiar to us. A mite was anciently thought the limit of littleness; but we are not now surprised to be told of animals twenty-seven millions of times smaller than a mite. Minute animals are found proportionably much stronger, more active and vivacious, than large ones. The spring of a flea in its leap, how vastly does it outstrip any thing greater animals are capable of! A mite, how vastly faster does it run than a race-horse! M. de l'Isle has given the computation of the velocity of a little creature, scarcely visible by its smallness, which he found to run three inches in half a second: supposing now its feet to be the fifteenth part of a line, it must make five hundred steps in the space of three inches; that is, it must shift its legs five hundred times in a second, or in the ordinary pulsation of an artery. The excessive minuteness of microscopical animalcules conceals them from the human eye. One of the wonders of modern philosophy is, to have invented means for bringing creatures, to us so imperceptible, under our cognizance and inspection: an object a thousand times too little to be able to affect our sense should seem to have been very safe. Yet we have extended our views over animals, to whom these would be mountains. In reality, most of our microscopical animalcules are of so small a magnitude, that through a lens, whose focal distance is the tenth part of an inch, they only appear as so many points; that is, their parts cannot be distinguished, so that they appear from the vertex of that lens under an angle not exceeding a minute. If we investigate the magnitude of such an object, it will be found nearly equal to $\frac{3}{1000000}$ of an inch long. Supposing, therefore, these animalcules of a cubic figure, that is, of the same length, breadth, and thickness, their magnitude would be expressed by the cube of the fraction $\frac{3}{1000000}$, that is, by the number $\frac{27}{1000,000,000,000,000,000}$, that is, so many parts of a cubic inch is each animalcule equal to. Leeuwenhoeck calculates, that a thousand millions of animalcula, which are discovered in common water, are not altogether so large as a grain of sand. This author, upon examining the male sperm of various animals, discovered in many infinite numbers of animalcula not larger than those above mentioned. In the milt of a single codfish there are more animals than there are, visible to the naked eye, upon the whole earth; for a grain of sand is bigger than four millions of them. The white matter that sticks to the teeth also abounds with animalcules of various figures, to which vinegar is fatal; and it is known that vinegar contains animalcules in the shape of eels. In short, according to this author, there is scarcely any thing which corrupts without producing food to myriads of animalcules. Animalcules are said to be the cause of various disorders. The itch is known to be a disorder arising from the irritation of a species of acarus, or tick, found in the pustules of that ailment: when the com-

munication of it by contact from one to another is easily conceived, as also the reason of the cure being effected by cutaneous applications. In the Philosophical Transactions, vol. lix., is a curious account of the animalcules produced from an infusion of potatoes, and another of hempseed, by the late Mr. Ellis. "On the 25th of May, 1768, Fahrenheit's thermometer 70°, I boiled a potatoe in the New River water, till it was reduced to a mealy consistence. I put part of it, with an equal proportion of the boiling liquor, into a cylindrical glass vessel, that held something less than half a wine-pint, and covered it close immediately with a glass cover. At the same time I sliced an unboiled potatoe, and, as near as I could judge, put the same quantity into a glass vessel of the same kind, with the same proportion of New River water not boiled, and covered with a glass cover, and placed both vessels close to each other." "On the 26th of May, 24 hours afterwards, I examined a small drop of each by the first magnifier of Wilson's microscope, whose focal distance is reckoned at 1-50th part of an inch; and, to my amazement, they were both full of animalcula, of a linear shape, very distinguishable, moving to and fro with great celerity, so that there appeared to be more particles of animal than vegetable life in each drop." "This experiment I have repeatedly tried, and always found it to succeed in proportion to the heat of the circumambient air; so that even in winter, if the liquors are kept properly warm, at least in two or three days the experiment will succeed." "I procured hemp-seed from different seedsmen in different parts of the town. Some of it I put into the New River water, some into distilled water, and some into very hard pump-water. The result was, that in proportion to the heat of the weather, or warmth in which they were kept, there was an appearance of millions of minute animalcula in all the infusions; and, some time after, oval ones made their appearance. These were much larger than the first, which still continued: these wriggled to and fro in an undulatory motion, turning themselves round very quick all the time they moved forwards.

ANIME, a resin obtained from the hymenæa courbaril, or locust tree, which is a native of North-America. It resembles copal very much in its appearance, but is readily soluble in alcohol, which copal is not. It is used as a varnish. Alcohol dissolves it completely; and distilled over, it acquires both the smell and taste of anime.

ANNALS, in matters of literature, a species of history, which relates events in the chronological order wherein they happened. They differ from perfect history in this, that annals are a bare relation of what passes every year, as a journal is of what passes every day; whereas history relates not only the transactions themselves, but also the causes, motives, and springs of actions. Annals require nothing but brevity, history demands ornament. Cicero informs us of the origin of annals: to preserve the memory of events, the pontifex maximus, says he, wrote what passed each year, and exposed it on tablets in his own house, where every one was at liberty to read: this they called *annales maximi;* and hence the writers who imitated this simple method of narrating facts were called annalists.

ANNATES, among ecclesiastical writers, a year's income of a spiritual living. These were, in ancient times, given to the pope throughout all Christendom, upon the decease of any bishop, abbot, or parish-clerk, and were paid by his successor. In England, the pope claimed them first of such foreigners as he conferred benefices upon, by way of provision; but afterwards they were demanded of all other clerks, on their admission to benefices. At the reformation they were taken from the pope, and vested in the king; and, finally, queen Anne restored them to the church, by appropriating them to the augmentation of poor livings.

ANNEALING, or NEALING, the burning or baking glass, earthen-ware, &c. in an oven or furnace. See GLASS.

ANNOTATION, in matters of literature, a brief commentary, or remark upon a book or writing, in order to clear up some passage, or draw some conclusion from it: thus the critics of the last age have made learned annotations upon all the classics.

ANNOTTO, in commerce, a kind of red dye, brought from the West-Indies. This is otherwise denominated arnatto. It is procured from the pulp of the seed capsules of a shrub called achiotte and urucu; the bixa orellana of Linnæus, which grows seven or eight feet high, and produces oblong hairy pods, somewhat resembling those of a chesnut. Within each of these are thirty or forty irregularly figured seeds, which are enveloped in a pulp of a bright red colour and unpleasant smell, somewhat resembling the paint

called red lead when mixed up with oil; and it was used as paint by some of the Indians, in the same manner as woad was used by the ancient Britons. The seeds, together with the red tough matter that surrounds them, are softened in a wooden trough with water, until, by a kind of fermentation, which spreads a very nauseous smell, and by diligent stirring and pounding, the kernels are separated from the pulp. This mass is then strained through a seive, and boiled; and upon which a thick reddish scum, which is the pigment, separates. When skimmed off, it is carefully inspissated in another kettle; and after being repeatedly cool, is moulded in roundish lumps, wrapt round with leaves of trees, and packed for sale. It seems to partake of the nature of vegetable albuminous matter. The method of extracting the pulp, and preparing it for market, is simply by boiling the seeds in clear water, till they are perfectly extricated; after which the seeds are taken out, and the water left undisturbed for the pulp to subside. It is then drained off, and the sediment distributed into shallow vessels, and dried generally in the shade. The annotto is now only prepared by the Spaniards. The English had formerly a manufacture at St. Angelo, now ruined. This drug is preferred by the dyers to indigo, and sold one-fourth dearer. The double Gloucester cheese is coloured with this dye, not with marygolds. Some of the Dutch farmers use it to give a rich colour to their butter, and great quantities are said to be applied to the same purpose in the English dairies. The poor people use it instead of saffron; and it is sometimes mixed as an ingredient in chocolate, during the grinding of the cocoa, in the quantity of about two drams to the pound, in order to give it a reddish colour; but the opinion of its being an earth has brought it into disrepute, and this use of it has been discontinued. To water it gives only a pale brownish yellow colour, and is not soluble in that liquid, nor in spirit of wine; but, in order to be fit for dyeing, it requires an alkaline menstruum, to which it gives a bright orange colour; and hence it is useful as an ingredient in varnishes and lacquers, and in dying wax of a vermillion colour. Wool and silk, boiled in a solution of it by alkaline salts in water, acquire a deep, but not a durable orange dye; for though it is not changed by alum or acids, it is discharged by soaps, and destroyed by exposure to the air. It is said to be an antidote to the poisonous juice of manihot, or cassada. The liquid, sold under the name of "Scott's nankeen dye," seems to be nothing but annotto dissolved in alkaline ley.

ANNOYANCE, in law, any injury done to a public place, as a high-way, bridge, or common river; or to a private way, as laying any thing that may breed infection, by encroaching, &c.

ANNUAL *plants*, generally called annuals, in gardening, signify such plants as are of one year's duration, or which continue for a few months only. Plants that rise from seed sown in the spring arrive at maturity in the summer or autumn following, producing flowers and ripe seed, and which afterwards perish in their tops and roots, are commonly regarded as annuals. The plants of this tribe are very numerous, as most of those of the herbaceous kinds, consisting of uncultivated plants, weeds, &c. and also a great number of cultivated garden and field plants, both of the esculent and flowery ornamental kinds, are of this description. The last sort are often termed simply annuals. These are divided into the hardy and tender kinds; the former are sown in places where they are designed to remain without transplanting, but the latter are usually sown in hot-beds, in order to be transplanted in the spring, either into pots or borders.

ANNUITIES, any income of a certain yearly amount, payable at particular periods, which may be either yearly, half-yearly, quarterly, monthly, weekly, or at any other intervals. They are usually distinguished into annuities certain, and contingent annuities, or such as are for an uncertain period, being determinable by some future event, such as the failure of a life or lives.

The present value of an annuity is that sum, which, if improved at compound interest, would be sufficient to pay the annuity; the present value of an annuity certain, payable yearly, and of which the first payment is to be made at the end of a year, may therefore be calculated in the following manner.

Suppose a person has 100*l.* due to him a twelve month hence, and he wishes to have the value of the same advanced immediately, the sum which ought to be given as an equivalent thereto, allowing 5 per cent. interest, is 95*l.* 4*s.* $9\frac{1}{4}$*d.* for this is the sum, which, put out to interest, at the rate of 5 per cent will, at the end of the year, amount to 100*l.* So also, if a person has 100*l.* due to him at the end of two years, and he wishes to have the value of the same advanced immediately, the sum which ought to be given as an equivalent

thereto is 90*l.* 14*s.* 0¾*d.* for this is the sum, which, put out at the same rate of interest, will, at the end of two years, amount to 100*l.* In like manner, if a person has 100*l.* due to him at the end of three years, and he wishes to have the same advanced immediately, the sum which ought to be given as an equivalent thereto is 86*l.* 7*s.* 8*d.* for this is the sum which, at the same rate of interest, will at the end of three years amount to 100*l.* And if these three values are added together, they will make 272*l.* 6*s.* 6*d.* being the sum which ought to be paid down for an annuity of 100*l.* for three years; as this sum improved at the given rate of interest is just sufficient to make the three yearly payments.

As the amount or present worth of 1*l.* for any given term is usually adopted as the foundation of calculations relating to annuities, let r represent the amount of 1*l.* in one year; that is, one pound increased by a year's interest; then r^n, or r raised to the power whose exponent is any given number of years, will be the amount of 1*l.* in those years; its increase in the same time is $r^n - 1$; now the interest for a single year, or the annuity corresponding with the increase, is $r - 1$; therefore as $r - 1$ is to $r^n - 1$, so is u (any given annuity) to a its amount: hence we have

$$\frac{u \times \overline{r^n - 1}}{r - 1} = a$$

Example.—To what sum will an annuity of 50*l.* amount in 6 years, at 5 per cent. per annum, compound interest?

$$\frac{50 \times \overline{1.05|^{6} - 1}}{.05} = 340l.\ 19s.\ 1d.$$

In this manner the amount of an annuity for any number of years, at any given rate of interest, may be found. But when the term of years is considerable, it will be more convenient to work by logarithms, by which the labour of all calculations relating to compound interest is greatly abridged. There is, however, little occasion in general to calculate the amount or present worth of annuities, except for particular rates of interest, as the following tables, and others of a similar nature, for different rates of interest, which are given in most books on compound interest, save much time and labour in common practice, and are therefore in general use.

TABLE I.

Shewing the amount of an annuity of 1*l.* in any number of years not exceeding 100, at 5 per cent. per annum compound interest.

Yrs	Amo.	Yrs.	Amount.	Yrs	Amount.
1	1,0000	35	90,3203	69	559,5510
2	2,0500	36	95,8363	70	588,5285
3	3,1525	37	101,6281	71	614,9549
4	4,3101	38	107,7095	72	650,9027
5	5,5256	39	114,0950	73	684,4478
6	6,8019	40	120,7998	74	719,6702
7	8,1420	41	127,8398	75	756,6537
8	9,5491	42	135,2317	76	795,4864
9	11,0266	43	142,9933	77	836,2607
10	12,5779	44	151,1430	78	879,0738
11	14,2068	45	159,7002	79	924,0274
12	15,9171	46	168,6852	80	971,2288
13	17,7130	47	178,1194	81	1020,7903
14	19,5986	48	188,0254	82	1072,8298
15	21,5786	49	198,4267	83	1147,4713
16	23,6575	50	209,3480	84	1184,8448
17	25,8404	51	220,8154	85	1245,0871
18	28,1328	52	232,8562	86	1308,3414
19	30,5390	53	245,4990	87	1374,7585
20	33,0659	54	258,7739	88	1444,4964
21	35,7192	55	272,7126	89	1517,7212
22	38,5052	56	287,3482	90	1594,6073
23	41,4305	57	302,7157	91	1675,3377
24	44,5020	58	318,8514	92	1760,1045
25	47,7271	59	335,7940	93	1849,1098
26	51,1135	60	353,5837	94	1942,5653
27	54,6691	61	372,2629	95	2040,6935
28	58,4026	62	391,8760	96	2143,7282
29	62,3227	63	412,4698	97	2251,9146
30	66,4388	64	434,0933	98	2365,5103
31	70,7608	65	456,7980	99	2484,7859
32	75,2988	66	480,6379	100	2610,0250
33	80,0638	67	505,6698		
34	85,0670	68	531,9533		

Example 1.—To what sum will an annuity of 105*l.* amount in 19 years, at 5 per cent. compound interest?

The number in the table opposite to 19 years is 30,5390, which multiplied by 105 gives the answer 3206*l.* 11*s.* 10*d.*

Example 2.—In what time will an annuity of 25*l.* amount to 3575*l.* at 5 per cent. compound interest?

Divide 3575*l.* by 25*l.* the quotient is 143; the number nearest to this in the table is 142,9933, and the number of years corresponding, or 43 years, is the answer.

The present worth of an annuity, or the sum to be given in one present payment as an equivalent for an annuity for any given number of years, is found on similar principles; for as 1*l.* is the present value of r^n (its amount in n years, and as the present value of any other amount, and consequently

of $\frac{u \times r^n - 1}{r - 1}$ must bear the same proportion to that amount, we have

$$\frac{u - \frac{u}{r^n}}{r - 1} = p.$$

Example.—What is the present value of 50*l.* per annum for 6 years, at 5 per cent. compound interest?

$$\frac{50 - \frac{50}{\overline{1.05}|^6}}{.05} = 253l.\ 15s.\ 8d.$$

But such questions are much more readily answered by the following table.

TABLE II.

Shewing the present value of an annuity of 1*l.* for any number of years not exceeding 100, at 5 per cent. per annum, compound interest.

Y.	Value.	Y.	Value.	Y.	Value.
1	,952381	35	16,374194	69	19,309810
2	1,859410	36	16,546852	70	19,342677
3	2,723248	37	16,711287	71	19.373978
4	3,545950	38	16,867893	72	19,403788
5	4,329477	39	17,017041	73	19,432179
6	5,075692	40	17,159086	74	19,459218
7	5,786373	41	17,294368	75	19,484970
8	6,463213	42	17,423208	76	19,509495
9	7,107822	43	17,545912	77	19,532853
10	7,721735	44	17,662773	78	19,555098
11	8,306414	45	17,774070	79	19,576284
12	8,863252	46	17,880066	80	19,599460
13	9,393573	47	17,981016	81	19,615677
14	9,898641	48	18,077158	82	19,633978
15	10,379658	49	18,168722	83	19,651407
16	10,837770	50	18,255925	84	19,668007
17	11,274066	51	18,338977	85	19,683816
18	11,689587	52	18,418073	86	19,698873
19	12,085321	53	18,493403	87	19,713212
20	12,462210	54	18,565146	88	19,726869
21	12,821153	55	18,633472	89	19,739875
22	13,163003	56	18,698545	90	19,752262
23	13,488574	57	18,760519	91	19,764059
24	13,797642	58	18,819542	92	19,775294
25	14,093945	59	18,875754	93	19,785994
26	14,375185	60	18,929290	94	19,796185
27	14,643034	61	18,980276	95	19,805821
28	14,898127	62	19,028834	96	19,815834
29	15,141074	63	19,075080	97	19,823937
30	15,372451	64	19,119124	98	19,832321
31	15,592810	65	19,161070	99	19,840406
32	15,802677	66	19.201019	100	19,837910
33	16,002549	67	19,239066		
34	16,192904	68	19,275301		

Example 1.—What is the present value of an annuity of 63*l.* to continue for 21 years?

The value in the table against 21 years is 12,821153, which multiplied by 63 gives the answer 807*l.* 14*s.* 7*d.*

Example 2.—What present sum is equivalent to a nett rent of 20*l.* per annum for 69 years?

The value in the table against 69 years is 19,309,810, which multiplied by 20 gives the answer 386*l.* 3*s.* 11*d.*

If any of the annuities in the above table, instead of being for an absolute term of years, had been subject to cease, if a given life should fail during the term, it is evident that the value would have been lessened in proportion to the probability of the life failing; and that if, instead of being for a certain number of years, the annuity depended wholly on the uncertain continuance of a given life or lives, its value must be ascertained by the probable duration of such life or lives. In order to compute the value of Life Annuities, therefore, it is necessary to have recourse to tables that exhibit the number of persons, which, out of a certain number born, are found to be living at the end of every subsequent year of human life, which thus shew what are termed the probabilities of life.

Various tables of this kind have been formed by the different writers on this subject, as Dr. Halley, Mr. Thomas Simpson, M. Kersseboom, M. de Parcieux, Dr. Price, Dr. Haygarth, Mr. Wargentin, M. Susmilch, and others; and the true method of computing the value of life annuities, according to the probabilities of any table of mortality, is laid down by Mr. William Morgan as follows:

"Was it *certain* that a person of a given age would live to the end of a year, the value of an annuity of 1*l.* on such a life would be the present sum that would increase in a year to the value of a life one year older, together with the value of the single payment of 1*l.* to be made at the end of a year; that is, it would be 1*l.* together with the value of a life aged one year older than the given life, multiplied by the value of 1*l.* payable at the end of a year. Call the value of a life of one year older than the given life N, and the value of 1*l.* payable at the end of a year $\frac{1}{r}$; then will the value of an annuity on the given life, on the supposition of a *certainty*, be $\frac{1}{r} + \frac{1}{r} \times N = \frac{1}{r} \times \overline{1+N}$. But the fact is, that it is uncertain whether the given life will exist to the end of the year or not; this last value, therefore, must be diminished in the proportion of this un-

certainty, that is, it must be multiplied by the probability that the given life will survive one year, or supposing $\frac{b}{a}$ to express this probability, it will be $\frac{b}{ar} \times \overline{1-N}$."

The values of annuities on the joint continuance of two lives are found by reasoning in a similar manner; and such values, both for single and joint lives, are given in the following tables.

TABLE III.

Shewing the value of an annuity of 1*l.* on a single life, at every age, according to the probabilities of the duration of life at Northampton, reckoning interest at 5 per cent. per annum.

Age.	Value.	Age.	Value.	Age.	Value.
Birth.	8,863	33	12,740	66	7,034
1 year	11,563	34	12,623	67	6,787
2	13,420	35	12,502	68	6,536
3	14,135	36	12,377	69	6,281
4	14,613	37	12,249	70	6,023
5	14,827	38	12,116	71	5,764
6	15,041	39	11,979	72	5,504
7	15,166	40	11,837	73	5,245
8	15,226	41	11,695	74	4,990
9	15,210	42	11,551	75	4,744
10	15,139	43	11,407	76	4,511
11	15,043	44	11,258	77	4,277
12	14,937	45	11,105	78	4,035
13	14,826	46	10,947	79	3,776
14	14,710	47	10,784	80	3,515
15	14,588	48	10,616	81	3,263
16	14,460	49	10,443	82	3,020
17	14,334	50	10,269	83	2,797
18	14,217	51	10,097	84	2,627
19	14,108	52	9,925	85	2,471
20	14,007	53	9,748	86	2,328
21	13,917	54	9,567	87	2,193
22	13,833	55	9,382	88	2,080
23	13,746	56	9,193	89	1,924
24	13,658	57	8,999	90	1,723
25	13,567	58	8,801	91	1,447
26	13,473	59	8,599	92	1,153
27	13,377	60	8,392	93	0,816
28	13,278	61	8,181	94	0,524
29	13,177	62	7,966	95	0,238
30	13,072	63	7,742	96	0,000
31	12,965	64	7,514		
32	12,854	65	7,276		

The values in this and the following tables suppose the payments to be made yearly, and to begin at the end of a year; but if all the payments are to be half-yearly payments, and to be made at the end of every half year from the time of purchase, the value will be increased about one-fifth of a year's purchase.

The above table is formed from the probabilities of life, as deduced from the register of mortality at Northampton for 46 years, from 1735 to 1780; and as it gives the mean values of lives between the highest and lowest, it is better adapted for general use than any other extant. It has of late years been generally adopted for calculating the rates of assurance on lives, and is well suited to this purpose; but it is by no means a proper table for individuals or societies to grant life annuities from; for having been formed from a register comprehending persons of all ages and conditions, it cannot give a correct representation of the duration and value of such lives as usually form a body of annuitants, such persons being generally a selection of the best lives from the common mass, the interest of every person who purchases an annuity on any life requiring that he should take care that it is a good life. The best table for regulating the grant of life annuities is that formed from the table of mortality published by Mr. D. Parcieux, from the lists of the French tontines, but even this table gives the values of the advanced ages considerably too low.

TABLE IV.

Shewing the value of an annuity of 1*l.* on a single life, at every age, according to the probabilities of life, in Mr. De Parcieux's table of the mortality. Interest at 5 per cent.

Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.
0	11,083	18	15,631	36	14,065	54	10,418	72	5,540
1	14,620	19	15,550	37	13,930	55	10,168	73	5,232
2	15,135	20	15,474	38	13,786	56	9,930	74	4,942
3	15,509	21	15,401	39	13,632	57	9,682	75	4,674
4	15,750	22	15,328	40	13,466	58	9,431	76	4,429
5	15,924	23	15,256	41	13,296	59	9,177	77	4,190
6	16,041	24	15,184	42	13,116	60	8,923	78	3,953
7	16,118	25	15,112	43	12,931	61	8,669	79	3,719
8	16,169	26	15,040	44	12,738	62	8,413	80	3,501
9	16,204	27	14,969	45	12,539	23	8,155	81	3,283
10	16,210	28	14,893	46	12,333	64	7,893	82	3,072
11	16,194	29	14,810	47	12,119	65	7,626	83	2,868
12	16,145	30	14,722	48	11,897	66	7,351	84	2,668
13	16,077	31	14,627	49	11,666	67	7,069	85	2,461
14	15,994	32	14,527	50	11,425	68	6,778	86	2,237
15	15,901	33	14,421	51	11,178	69	6,479	87	1,976
16	15,807	34	14,306	52	10,926	70	6,171	88	1,688
17	15,716	35	14,189	53	10,673	71	5,856	89	1,409
								90	1,164

The calculation of the values of joint lives from any given table of mortality, for every combination of age, is so laborious a task, that no such table has yet been published. Mr. Simpson, in his select exercises, gave a table of the values of two joint lives, agreeable to the probabilities of life in London; but the tables founded on the London bills, representing the rate of mortality among the inhabitants, taken in the gross, give the values of lives much too low for the middling and superior classes of the people in London itself, and are wholly improper for general use. A much more comprehensive table of the value of joint lives has since been calculated by Dr. Price from the Northampton table of mortality, from which the following table is taken.

TABLE V.

Shewing the value of an annuity of 1*l.* on the joint continuance of two lives, according to the probabilities of life at Northampton. Interest at 5 per cent.

Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.
5–5	11,984	10–45	9,900	20–25	10,989	25–80	3,308	40–45	8,643	55–55	6,735
5–10	12,315	10–50	9,260	20–30	10,707	30–30	10,255	40–50	8,177	55–60	6,272
5–15	11,954	10–55	8,560	20–35	10,363	30–35	9,954	40–55	7,651	55–65	5,671
5–20	11,561	10–60	7,750	20–40	9,937	30–40	9,576	40–60	7,015	55–70	4,893
5–25	11,281	10–65	6,803	20–45	9,448	30–45	9,135	40–65	6,240	55–75	4,006
5–30	10,959	10–70	5,700	20–50	8,861	30–50	8,596	40–70	5,298	55–80	3,076
5–35	10,572	10–75	4,522	20–55	8,216	30–55	7,999	40–75	4,272	60–60	5,888
5–40	10,102	10–80	3,395	20–60	7,463	30–60	7,292	40–80	3,236	60–65	5,372
5–45	9,571	15–15	11,960	20–65	6,576	30–65	6,447	45–45	8,312	60–70	4,680
5–50	8,941	15–20	11,585	20–70	5,532	30–70	5,442	45–50	7,891	60–75	3,866
5–55	8,256	15–25	11,324	20–75	4,424	30–75	4,365	45–55	7,411	60–80	2,992
5–60	7,466	15–30	11,021	20–80	3,325	30–80	3,290	45–60	6,822	65–65	4,960
5–65	6,546	15–35	10,655	25–25	10,764	35–35	9,680	45–65	6,094	65–70	4,378
5–70	5,472	15–40	10,205	25–30	10,499	35–40	9,331	45–70	5,195	65–75	3,665
5–75	4,362	15–45	9,690	25–35	10,175	35–45	8,921	45–75	4,206	65–80	2,873
5–80	3,238	15–50	9,076	25–40	9,771	35–50	8,415	45–80	3,197	70–70	3,930
10–10	12,665	15–55	8,403	25–45	9,304	35–55	7,849	50–50	7,522	70–75	3,347
10–15	12,302	15–60	7,622	25–50	8,739	35–60	7,174	50–55	7,098	70–80	2,675
10–20	11,906	15–65	6,705	25–55	8,116	35–65	6,360	50–60	6,568	75–75	2,917
10–25	11,627	15–70	5,631	25–60	7,383	35–70	5,382	50–65	5,897	75–80	2,381
10–30	11,304	15–75	4,495	25–65	6,515	35–75	4,327	50–70	5,054	80–80	2,018
10–35	10,916	15–80	3,372	25–70	5,489	35–80	3,268	50–75	5,112	85–85	1,256
10–40	10,442	20–20	11,232	25–75	4,396	40–40	9,016	50–80	3,140	90–90	0,909

To find the value of any annuity during the continuance of a life of any given age, or during the joint continuance of two lives, it is only necessary to multiply the value in the table, against the given age, by the annuity; or to find the annuity equivalent to any certain sum, divide the sum by the value in the table against the given age.

EXAMPLES.—What is the difference in value between an annuity of *50l.* during the life of a person aged 35, and an annuity of *60l.* during two lives of 30 and 35, to cease when either of the two lives shall fail ?

The value in Table III. against the age of 35 is 12,502, which multiplied by 50 gives 625.1*l.* the value in table V. against the ages of 30 and 35 is 9.954, which multiplied by 60 gives 597.24*l.* the value of the former annuity therefore exceeds the latter by 27*l.* 17*s.* 2*d.*

What annuity during his life, ought a person aged 45 to receive in lieu of an annuity of 20*l.* certain for the term of 18 years ?

The value of an annuity certain for 18 years, is by Table II. 11.689587, which multiplied by 20 gives 233.7917*l.* this sum divided by 11.105, the value of an annuity during a life of 45, by Table III. gives the answer of 21*l.* 1*s.*

What annuity during his life, ought a person aged 40 to receive for 500*l.*

The value of an annuity during a life of 40 years of age, is by Table III. 11.837, and 500*l.* divided by this sum gives 42*l.* 4*s.* 9*d.* per annum ; but if the value of the life is taken, as in Table IV. (or 13.466), the sum to be received will be 37*l.* 2*s.* 7*d.*

For the values of annuities which are not to commence till after a certain period, or after a given life or lives. See REVERSIONS.

Annuities are frequently granted by parishes, trusts, and public societies, for the purpose of raising money for the erection or repair of churches, chapels, workhouses, bridges, or other expensive buildings, it being often found practicable to obtain money in this way, when it could not be procured at the ordinary rate of interest; it has likewise the recommendation of gradually extinguishing the debt, which might otherwise often remain a permanent burthen. Life annuities are also frequently granted, for money borrowed by persons possessing life estates, and who, therefore, cannot give the lender a permanent security. As such annuities depend on the life of the grantor, few persons are disposed to purchase them, unless they can be obtained on such terms, as, after allowing for the expense of assuring the grantor's life, leaves an income somewhat greater than the common rate of interest. It also frequently happens that the annuities are not very punctually paid, which, with other risks attending them, causes annuities of this description always to sell considerably under their real value; and in some instances the necessities of the borrowers have led them to make grants of this kind on the most exorbitant terms. To throw, however, some check upon improvident transactions of this kind, which are usually carried on with great privacy, the statute 17 Geo. III. c. 26, usually called the Annuity Act, has directed, that upon the sale of any life annuity of more than the value of 10*l.* (unless on a sufficient pledge of lands in fee simple, or stock in the public funds) the true consideration, which shall be in money only, and the names of the parties, shall be set forth and described in the security itself, in words at length; and a memorial of the date, the names of the parties, and of all the witnesses, and of the consideration money, shall, within twenty days after its execution, be enrolled in the Court of Chancery, else the security shall be null and void. All contracts for the purchase of annuities from persons under 21 years of age are utterly void, and incapable of confirmation after the party becomes of age. Procuring or soliciting a minor to grant any life annuity, or to promise or engage to ratify it when he becomes of age, is an indictable misdemeanor, and punishable by fine and imprisonment; as is likewise the taking more than ten shillings per cent. for procuring money to be advanced for any life annuity. This act does not extend to annuities granted by any body corporate, or under any authority or trust created by act of parliament.

Notwithstanding these regulations, persons having occasion to raise money by the grant of life annuities were obliged to submit to the most disadvantageous terms, as it seldom happened that individual purchasers would give for such annuities more than eight years purchase, on lives above 30 years of age; or 7 years purchase on lives above 40; while, on the other hand, persons desirous of investing money in an annuity on their own life were generally under the necessity of accepting private security, or of waiting till an opportunity offered of obtaining the security of some local toll or rates. To remedy these inconveniences, an act was

passed in 1793, authorising the Royal Exchange Assurance Company to grant and purchase annuities on lives, either immediate or in reversion: the rates according to which transactions of this kind are regulated necessarily vary, in proportion to the current rate of interest at which money can be improved: a short specimen therefore of the present (1808) rates, at which the Royal Exchange Assurance grant life annuities, will be sufficient.

Age.	per cent. per ann.	Age.	per cent. per ann.
15	5*l*. 18*s*. 0*d*.	50	7*l*. 16*s*. 0*d*.
20	6 0 0	55	8 6 0
25	6 2 0	60	9 4 0
30	6 6 0	65	10 4 0
35	6 10 0	70	11 8 0
40	6 16 0	75	12 18 0
45	7 6 0	80	14 8 10

Several other societies, as the Globe Insurance, the Albion, the Rock, and the Eagle Insurance Companies, have lately granted life annuities, but it is presumed they vary their grants according to circumstances, as they none issue a printed table of their rates.

ANOMALIES, in music, are those false scales or intervals, which exist necessarily in all keyed instruments, from their incapacity of a true and perfect temperament.

ANOMALISTICAL *year*, in astronomy, the time that the earth takes to pass through her orbit: it is also called a periodical year. The space of time belonging to this year is greater than the tropical year, on account of the precession of the equinoxes.

ANOMALOUS *verbs*, in grammar, such as are not conjugated conformably to the paradigm of their conjugation: they are found in all languages; in Latin, the verb *lego* is the paradigm of the third conjugation, and runs thus, *lego, legis, legit*; by the same rule it should be, *fero, feris, ferit*, but we say, *fero, fers, fert*; *fero* then is an anomalous verb. In English, the irregularity relates often to the preter tense and passive participle; for example, *give*, were it formed according to rule, would make *gived* in the preter tense and passive participle; whereas in the former, it makes *gave*, and in the latter *given*.

ANOMALY, in grammar, that quality in words which renders them anomalous. See the preceding article.

ANOMALY, in astronomy, an irregularity in the motion of the planets, whereby they deviate from the aphelion or apogee: which inequality is either mean, eccentric, or coequate and true.

ANOMIA, in natural history, a genus of worms, of the order Testacea. Animal an emarginate ciliate strap-shaped body, with bristles affixed to the upper-valve; two arms, linear, longer than the body, connivent, projecting, alternate on the valve, and ciliate each side, the fringe affixed to each valve; shell bivalve, inequivalve; one of the valves flattish, the other gibbous at the base, with a produced beak, generally curved over the hinge; one of the valves often perforated near the base; hinge with a linear prominent cicatrix and a lateral tooth placed within, but in the flat valve on the very margin; two bony rays for the base of the animal. There are nearly fifty species enumerated by Gmelin, found in different parts of the world. A ephippium has a shell, roundish, pellucid, with wrinkled plaits; the flat valve perforated. It inhabits European and American seas, and is frequently found sticking to the common oyster. About two inches long, 2¼ broad; the outside rugged and filmy, the inside smooth and pearly: varies in colour, but generally with a silvery hue.

ANONA, in botany, a genus of plants, belonging to the Polyandria Polygynia class of Linnæus. The perianthium is composed of three cordated, hollowed, and acuminated leaves; the corolla consists of six cordated sessile petals, three alternately interior and smaller; the stamina are scarce visible, but the antheræ are numerous; the fruit is a large berry, of an oval figure; covered with a squamose punctuated bark; the seeds are numerous, hard, of an oblong figure, and are placed circularly.

ANSERES, in natural history, the third order of birds, according to the Linnæan system: they are distinguished by a smooth bill, covered with a soft skin and broader at the point; feet formed for swimming; toes palmate, connected by a membrane; shanks short, and compressed; body fat and downy; flesh mostly tough; their food is fish, frogs, aquatic plants, worms, &c. They make their nests generally on the ground; the mother takes but little care in providing for the young. They are frequently polygamous. They are divided into those genera having bills with, and those without, teeth: of the former are the

Anas,	Phaëton, and
Mergus,	Plotus.

Of the latter are the

Alca,	Pelecanus,
Aptenodytes,	Procellaria,
Colymbus,	Prynchops,
Diomedea,	and
Larus,	Sterna.

This order comprehends all kinds of water-fowl whose feet are palmated. The webbed feet of these birds are admirably adapted to aid them in swimming; and the greater quantity of oil secreted by the glands near the tail, and rubbed by means of their bills over all the feathers of their body, enables them to live on the water, without ever being wet. They live mostly on fish, and some of them have been occasionally tamed to the catching of fish for the use of their masters. In some of the lakes of China, where the water-fowl abound, the natives have the following ingenious mode of catching them: For several days before they attempt to take them, many empty gourd-shells are set afloat on the water, to habituate the birds to their appearance; and when they are observed to take no notice of these shells, but to swim among them, a man, with one of the same kind upon his head, goes into the lake, and wades or swims among the birds with nothing but his head above the water. He now begins his sport, and taking the birds by their legs, draws them under water, breaks their necks, and fastens them to his girdle, one after another, till he is sufficiently loaded, and then returns to the shore.

ANSWER, in law: On an indictment for perjury, in an answer in Chancery, it is a sufficient proof of identity, if the name subscribed be proved to be the hand-writing of the defendant; and that the same was subscribed by the master, on being sworn before him.

ANT. See FORMICA.

ANTECEDENCE, in astronomy, an apparent motion of a planet towards the west, or contrary to the order of the signs, *viz.* from Taurus towards Aries, &c.

ANTECEDENT, in grammar, the word to which a relative refers: thus, God whom we adore, the word God is the antecedent to the relative whom.

ANTECEDENT *term*, in mathematics, the first one of any ratio: thus, if the ratio be $a : b$, a is the antecedent term.

ANTEDATE, among lawyers, a spurious or false date, prior to the true date of a bond, bill, or the like.

ANTELOPE, in natural history, of the Mammalia class of animals, of the order Glires. The generic character is, horns hollow, seated on a bony core, growing upwards, annulated or wreathing, permanent. Front teeth in the lower jaw eight, and no canine teeth. Antelopes constitute a very numerous race: they were formerly, even by Linnæus, ranged under the genus Capra, but now have obtained a rank for themselves: their habits and manners are thus described. They inhabit, two or three species excepted, the hottest parts of the globe; or, at least, those parts of the temperate zone that lie so near the tropics as to form a doubtful climate. None, therefore, except the Saiga and the Chamois, are to be met with in Europe; and notwithstanding the warmth of South America is suited to their nature, but one or two species has yet been discovered in the new world. Their proper climates seem, therefore, to be those of Asia and Africa, where the species are very numerous. "As there appears a general agreement in the nature of the species that form this great genus, it will prevent needless repetition to observe, that the antelopes are animals generally of a most elegant and active make; of a restless and timid disposition; extremely watchful, of great vivacity, remarkably swift and agile, and most of their boundings so light and elastic, as to strike the spectator with astonishment. What is very singular is, that they will stop in the midst of their course, gaze for a moment at their pursuers, and then resume their flight. As the chase of these animals is a favourite amusement with the eastern nations, from that may be collected proofs of the rapid speed of the antelope tribe. The greyhound, the fleetest of dogs, is usually unequal in the course, and the sportsman is obliged to call in the aid of the falcon, trained for the purpose, to seize on the animal, and impede its motions, in order to give the dogs an opportunity of overtaking it. In India and Persia a species of leopard is made use of in the chase: this is an animal that takes its prey, not by swiftness of foot, but by the greatness of its springs, by motions similar to those of the antelope; but, should the leopard fail in its first essay, the game escapes. The fleetness of the antelope was proverbial in the country it inhabited, even in the earliest times: the speed of Asahel (2 Sam. ii. 18.) is beautifully compared to that of the Tzebi; and the Gadites were said to be as swift as the antelopes upon the mountains. The sacred writers took their similies from such objects as were before the eyes of the people to whom they addressed themselves.

There is another instance drawn from the same subject: the disciple raised to life at Joppa was supposed to have been called Tabitha, *i. e.* Dorcas, or the antelope, from the beauty of her eyes; and to this day one of the highest compliments that can be paid to female beauty, in the eastern regions, is *Aine el Czazel,* 'You have the eyes of an antelope.' Some species of antelopes form herds of two or three thousands, while others keep in troops of five or six. They generally reside in hilly countries, though some inhabit plains: they often brouse like the goat, and feed on the tender shoots of trees, which gives their flesh an excellent flavour. This is to be understood of those which are taken in the chace; for those which are fattened in houses are far less delicious. The flesh of some species are said to taste of musk, which perhaps depends on the qualities of the plants they feed upon." This preface (says Mr. Pennant) was thought necessary, to point out the difference in nature between this and the goat kind, with which most systematic writers have classed the antelopes: but the antelope forms an intermediate genus, a link between the goat and the deer; agreeing with the former in the texture of the horns, which have a core in them, and are never cast; and with the latter in elegance of form and swiftness.

The Common Antelope.—The Antelope, properly so called, abounds in Barbary, and in all the northern parts of Africa. It is somewhat less than the fallow-deer: its horns are about sixteen inches long, surrounded with prominent rings almost to the top, where they are twelve inches distant from point to point. The horns of the antelope are remarkable for a beautiful double flexion, which gives them the appearance of the lyre of the ancients. The colour of the hair on the back is brown, mixed with red; the belly and inside of the thighs white; and the tail short.

The Striped Antelope,—is a beautiful, tall gazelle, inhabiting the Cape of Good Hope; has long, slender shanks; its horns are smooth, twisted spirally, with a prominent edge or rib following the wreaths; they are three feet nine inches long, of a pale-brown colour, close at the base, and at the points round and sharp. The colour of this animal is a rusty brown; along the ridge of the back there is a white stripe mixed with brown; from this are eight or nine white stripes pointing downwards; the forehead and the fore part of the nose are brown; a white stripe runs from the corner of each eye, and meets just above the nose; upon each cheek-bone there are two small white spots; the inner edges of the ears are covered with white hair, and the upper part of the neck is adorned with a brown mane, an inch long; beneath the neck, from the throat to the breast, are some long hairs hanging down; the breast and belly are grey; the tail is two feet long, brown above, white beneath, and black at the end.

The Gnu, the Hottentot name for a singular animal, which, with respect to its form, is between the horse and the ox.—It is about the size of a common galloway, the length of it being somewhat above five feet, and the height rather more than four. This animal is of a dark brown colour: the tail and mane of a light grey; the shag on the chin and breast, and the stiff hairs which stand erect on the forehead and upper part of the face, are black; the curvature of the horns is singular; and the animal is represented in the figure in the attitude of butting, to give an idea of their form and position. The legs of the gnu are small; its hair is very fine; and it has a cavity beneath each eye, like most of the antelope kind.

The Chevrotain and Meminna.—The Chevrotain, or little Guinea Deer, is the smallest of all the antelope kind, the least of all cloven-footed quadrupeds, and, we may add, the most beautiful. Its legs at the smallest part are not much thicker than a tobacco-pipe; it is not more than seven inches in height, and about twelve from the point of the nose to the insertion of the tail; its ears are broad, and its horns, which are straight, and scarcely two inches long, are black and shining as jet; the colour of the hair is a reddish brown; in some a beautiful yellow, very short and glossy. These elegant little creatures are natives of Senegal and the hottest parts of Africa; they are likewise found in India, and in many of the islands belonging to that vast continent. In Ceylon, there is an animal of this kind, called Meminna, which is not larger than a hare, but perfectly resembling a fallow-deer. It is of a grey colour; the sides and haunches are spotted and barred with white; its ears are long and open; and its tail short. None of these small animals can subsist but in a warm climate. They are so extremely delicate, that it is with the utmost difficulty they can be brought alive into Europe, where they soon perish. They are gentle, familiar, most beautifully formed, and their agility is such, that they will

bound over a wall twelve feet high. In Guinea, they are called Guevei. The female has no horns.

The Springer Antelope,—is an elegant species, weighs about fifty pounds, and is rather less than a roe-buck; inhabits the Cape of Good Hope; called there the Spring bock, from the prodigious leaps it takes on the sight of any body. When alarmed, it has the power of expanding the white space about the tail into the form of a circle, which returns to its linear form when the animal is tranquil. They migrate annually from the interior parts in small herds, and continue in the neighbourhood of the Cape for two or three months; then join companies and go off in troops, consisting of many thousands, covering the great plains for several hours in their passage: are attended in their migrations by numbers of lions, hyænas and other wild beasts, which make great destruction among them: are excellent eating, and, with other antelopes, are the venison of the Cape. Mr. Masson informs us, that they also make periodical migrations, in seven or eight years, in herds of many hundred thousands, from the north, as he supposes from the interior parts of Terra de Natal. They are compelled to it by the excessive drought which happens in that region, when sometimes there does not fall a drop of rain for two or three years. These animals, in their course, desolate Caffraria, spreading over the whole country, and not leaving a blade of grass. Lions attend them: where one of these beasts of prey are, the place is known by the vast void visible in the midst of the timorous herd. On its approach to the Cape, it is observed that the avant guard is very fat, the centre less so, and the rear guard almost starved, being reduced to live on the roots of the plants devoured by those which went before; but on their return they become the avant guard, and thrive in their turn on the renewed vegetation; while the former, now changed into the rear guard, are famished, by being compelled to take up with the leavings of the others. These animals are quite fearless, when assembled in such mighty armies, nor can a man pass through, unless he compels them to give way with a whip or stick. When taken young, they are easily domesticated; the males are very wanton, and are apt to butt at strangers with their horns. The expansile white part on the end of the back of this animal is a highly singular circumstance. It is formed by a duplicature of the skin in that part, the inside and edges being milk-white; when the animal is at rest, the edges alone appear, resembling a white stripe, but when alarmed, or in motion, the cavity, or white intermediate space, appears in form of a large oval patch of that colour.

The Scythian Antelope, or Saiga,—which is the only one of the species that is to be found in Europe. The form of its body resembles the domestic goat, but its horns are those of an antelope, being marked by very prominent rings, with furrows between; they are a foot long, the ends smooth, of a pale yellow colour, almost transparent. The male is covered with rough hair, like the he-goat, and has a strong scent; the female is smoother, hornless, and timid. The general colour is a dirty white. When they are attacked by wolves or dogs, the males stand round the females, forming a circle, with their heads towards the enemy, in which posture they defend their charge. Their common pace is a trot; when they go faster, it is by leaps; and are swifter than roe-bucks. When they feed, they are obliged to go backward, owing to the length of the upper lip, which they lift up. Their skin is soft and excellent for gloves, belts, &c. They are found in flocks from six to ten thousand, on the banks of the Tanais and Boristhenes. The young are easily tamed, and will readily return to their master when turned out on the desert.

The Nilgau, or White-footed Antelope,—is a large and beautiful species, known only within the space of a few years past. Its height is four feet one inch to the top of the shoulders, and its length, from the bottom of the neck to the base of the tail, four feet. The colour of the nilgau is a fine dark-grey, or slate-colour, with a large spot of white beneath the throat, and two white bands or marks above each foot: the ears are large, white within, and edged with the same colour, and marked internally by two black stripes; along the top of the neck runs a slight mane of black hair, which is continued to some distance down the back, and on the breast is a much longer mane or hanging tuft, of a similar colour; the tail is moderately long, and terminated by a tuft of black hair: the horns are short, pointed, smooth, triangular at their base, distant from each other, bent very slightly forwards, and of a blackish colour. The female resembles the male in general appearance, but is considerably smaller, of a pale brown colour, and is destitute of horns: the mane, pectoral tuft, and ears, resemble those of the male, and the feet are marked above the hoofs by three transverse bars of black

and two of white. The nilgau is a native of the interior parts of India. According to Mr. Pennant, it abounded in the days of Aurengzebe between Delli and Lahor, on the way to Cashmire, and was called nylgau, or the blue or grey bull. It was one of the objects of the chace with that mighty monarch during his journey: they were inclosed by his army of hunters within nets, which, being drawn closer and closer, at length formed a small precinct, into which the king and his omrahs and hunters entered, and killed the nilgaus with arrows, spears, and muskets; and that sometimes in such numbers, that Aurengzebe used to send quarters as presents to all his great people. The nylgau has of late years been often imported into Europe, and has bred in England. In confinement it is generally pretty gentle, but is sometimes seized with fits of sudden caprice, when it will attack with great violence the objects of its displeasure. When the males fight, they drop on their knees at some distance from each other, and gradually advance in that attitude, and at length make a spring at each other with their heads bent low. This action, however, is not peculiar to the nilgau, but is observed in many other of the antelope tribe. The nilgau is said to go with young about nine months, and to produce sometimes two at a birth: the young is of the colour of a fawn.

Antelope Leucoryx, or White Antelope, —is entirely milk-white, except the markings on the face and limbs. It is an inhabitant of an island in the Gulf of Bassora. See Plate Mammalia, fig. 1—6.

ANTHEM, a church song performed in cathedral service by choristers, who sing alternately. It was formerly used to denote both psalms and hymns, when sung in this manner. But at present, anthem is used in a more confined sense, being applied to certain passages taken out of the scriptures, and adapted to a particular solemnity.

ANTHEMIS, in botany, *chamomile*, a genus of the Syngenesia Superflua class and order. Receptacle chaffy; seeds generally crowned with a slight border; calyx hemispherical, nearly equal; florets of the ray more than five, oblong. There are two divisions of this genus, namely, A. with a differently coloured or white ray; and B. ray the colour of the disk, or yellow: there are about forty species.

ANTHERÆ, among botanists, denote the little roundish or oblong bodies, on the tops of the stamina of plants.

The antheræ is the principal part of the male organ of generation in plants, answering the glans penis in animals. It is tumid and hollow, containing a fine powder, called farina fœcundans.

ANTHERICUM, in botany, a genus of plants of the Hexandria Monogynia class and order. Cor. six-petalled, spreading, permanent; filaments uniform; capsule superior, seeds angular. There are three divisions. A. leaves channelled; filaments mostly beardless: B. leaves fleshy; filaments bearded: C. stamina dilated in the middle; root bulbous. There are between 50 and 60 species.

ANTHERYLIUM, a genus of the Icosandria Monogynia class and order. Calyx inferior, four-parted; petals four; capsule one-celled, three-valved, many-seeded. There is but a single species, a tree found at St. Thomas's Island.

ANTHISTERIA, in botany, a genus of the Polygamia Monoecia class and order. Hermaphrodite; florets sessile, male florets pedicelled; calyx four-valved, three or four flowered, coriaceous; corol. glume two-valved, awnless; filaments three; styles two; stigmata clavate; seed one. There is but a single species.

ANTHOCEROS, a genus of the Cryptogamia Hepaticæ. Male; six parted or entire; antheræ three to eight, obovate, in the bottom of the calyx. Female; calyx sessile, cylindrical and entire. There are four species.

ANTHOLOMA, in botany, a genus of the Polyandria Monogynia class and order. Calyx two to four-leaved; cor. cup-shaped; many seeded. There is but a single species, a shrub found in Caledonia.

ANTHOLYZA, in botany, a genus of the Triandria Monogynia class and order. Corol. tubular, six-cleft, unequal, recurved; capsule inferior. There are six species, all found at the Cape.

ANTHOSPERMUM, in botany, the *amber-tree*, a genus of plants belonging to the Tetrandria class and order. It is male and female, in different plants, and some are hermaphrodites. The androgynous flower is of one leaf, with two pistils and four stamina, with the germen below the flower. The male flowers are the same with these, wanting only the pistils and germen. The female flowers have the pistils and germen, but want the stamina. There are three species.

ANTHOXANTHUM, in botany, a genus of the Dyandria Digynia class and order. Gen. char. calyx, glume two-valved, one flowered; corol. glume two-valved, pointed, awned; seed one. There are four species.

ANTHRENUS, in natural history, a

genus of insects of the order Coleoptera. Essen. char. antennæ clavate, the club solid; feelers unequal, filiform; jaws membranaceous, linear, bifid; lip entire; head hidden under the thorax. There are 13 species, of which the muscoreum is very destructive to collections of preserved animals, insects, &c.

ANTHROPOMORPHA, in the Linnæan system of zoology, a class of animals, resembling in some degree the human form; the distinguishing characteristic of which is, that all the animals comprehended in it have four fore teeth in each jaw, and the teats are situated on the breast. Besides the human species, which stands at the head of this class, it likewise comprehends the monkey and sloth kinds.

ANTHYLLIS, the *bladder lotus*, in botany, a genus of the Diadelphia Decandria class of plants, the corolla whereof is papilionaceous; the fruit is a small roundish legume, composed of two valves, and containing one or two seeds. This genus is separated into the A. herbaceous, and B. shrubby; there are of the former 12 species, of the latter nine.

ANTICHORUS, in botany, a genus of the Octandria Monogynia class and order. Calyx four-leaved; petals four; capsule superior, subulate, four-celled, four-valved; seeds numerous. There is only one species, found in Arabia.

ANTIDESMA, in botany, a genus of the Dioecia Pentandria class of plants, the calyx of which is a perianthium, consisting of five oblong, concave leaves; there is no corolla; the fruit is a cylindric berry, containing one cell, in which is lodged a single seed. There are three species, found in the East Indies and China.

ANTIMONY, in mineralogy, one of the metals that is brittle and easily fused. No metal has attracted so much of the attention of physicians as antimony. One party has extolled it as an infallible specific for every disease: while another decried it as a most virulent poison, which ought to be expunged from the list of medicines. Antimony, as it occurs under that name in the shops, is a natural compound of the metal with sulphur. To obtain it in a metallic state, the native sulphuret is to be mixed with two-thirds its weight of acidulous tartrite of potash, (in the state of crude tartar,) and one-third of nitrate of potash deprived of its water of crystallization. The mixture must be projected, by spoonfuls, into a red-hot crucible; and the detonated mass poured into an iron mould greased with a little fat. The antimony, on account of its specific gravity, will be found at the bottom, adhering to the scoriæ, from which it may be separated by the hammer. Or three parts of the sulphuret may be fused in a covered crucible, with one of iron filings. The sulphur quits the antimony, and combines with the iron. Antimony in its metallic state (sometimes called regulus of antimony) is of a silvery white colour, very brittle, and of a plated or scaly texture. It is fused by a moderate heat; and crystallizes, on cooling, in the form of pyramids. In close vessels it may be volatilized, and collected unchanged. It undergoes little change when exposed to the atmosphere at its ordinary temperature; but when fused, with the access of air, it emits white fumes, consisting of an oxide of the metal. This oxide had formerly the name of flowers of antimony. Antimony combines with phosphorus and sulphur. With the latter, an artificial sulphuret is formed, exactly resembling the native compound, which last may be employed, on account of its cheapness, for exhibiting the properties of this combination of antimony. Antimony is dissolved by most of the acids. Sulphuric acid is decomposed, sulphurous acid being disengaged, and an oxide formed, of which a small proportion only is dissolved by the remaining acid. Nitric acid dissolves this metal with great vehemence; muriatic acid acts on it by long digestion; but the most convenient solvent is the nitro-muriatic acid, which, with the aid of heat, dissolves it from the native sulphuret. With oxygenized muriatic acid, it forms a compound of a thick consistence, formerly called butter of antimony. This may be formed by exposing black sulphuret of antimony to the fumes of oxygenized muriatic acid, and subsequent distillation; or by distilling the powdered regulus with twice its weight of corrosive muriate of mercury. The metal becomes highly oxydized, and unites with muriatic acid in its simple state. On pouring this compound into water, a white oxide falls down, called powder of algaroth. Antimony is susceptible of various states of oxydizement. The first oxide may be obtained by washing algaroth powder with a little caustic potash. It is composed of 18½ oxygen, and 81½ metal. That formed by the action of nitric acid on antimony contains 77 metal, and 23 oxygen. See ORES, *analysis of*.

ANTINOMIANS, in church history, a sect of Christians, who reject the moral law as a rule of conduct to believers,

disown personal and progressive sanctification, and hold it to be inconsistent for a believer to pray for the forgiveness of sins. Although these principles will, by some, be thought to lead to mischievous consequences and practice, yet there are, unquestionably, worthy men and virtuous Christians, who avow Antinomian tenets. To the young, the giddy, and the thoughtless, such sentiments might, if acted upon, be the source of much evil; but these, like the doctrine of necessity, are rarely believed, but by persons who have already attained to virtuous habits.

ANTIPATHES, in natural history, a genus of worms of the order Zoophyta. An animal growing in the form of a plant: stem expanded at the base, internally horny, beset with small spines, externally covered with a gelatinous flesh, beset with numerous polype-bearing tubercles. There are 13 species. A. spiralis inhabits the Indian, Mediterranean, and North seas; of a hard, horny, black substance, exceeedingly brittle, very long, and variously twisted, about the size of a writing pen. A alopecuroides, with spinous setaceous closely panicled branches; inhabits South Carolina; about two feet high, and rises from a broad spread base, dividing into several large branches, flat on one side, with a groove along the middle; it then subdivides into smaller branches, forming close panicles, not unlike the fox-tail grass: the outside greyish, the inside black, and very brittle.

ANTIPODES, in geography, a name given to those inhabitants of the globe that live diametrically opposite to one another. They lie under opposite parallels, and opposite meridians. They have the same elevation of their different poles. It is mid-night with the one, when it is noon-day with the other; the longest day with one is the shortest with the other; and the length of the day with the one is equal to the night of the other. See Globes, *use of*.

ANTIQUARY, a person who studies and searches after monuments and remains of antiquity.

There were formerly, in the chief cities of Greece and Italy, persons of distinction, called antiquaries, who made it their business to explain the ancient inscriptions, and give every other assistance in their power to strangers, who were lovers of that kind of learning. Foundations of this kind have existed in England. Sir H. Spelman speaks of a society of antiquaries in his time, which had been instituted in 1572, by Archbishop Parker, Camden, Sir Robert Cotton, Stowe, and others. Application was made in 1589 to Queen Elizabeth for a charter, and house, in which they might hold their meetings, erect a library, &c. But the death of the sovereign put an end to the design. In 1717, this society was revived again, and has continued without interruption; and at present, it is in a very flourishing state, consiting of learned men in every rank of life. The society was incorporated in 1751, and began to publish an account of its discoveries in 1770, under the title of "Archæologia:" fifteen volumes in quarto are already published.

ANTIQUITIES, a term implying all testimonies, or authentic accounts, that have come down to us of ancient nations. According to Lord Bacon, antiquities may be considered as the wrecks of history, or such particulars as industrious and learned persons have collected from genealogies, inscriptions, monuments, coins, names, etymologies, archives, instruments, fragments of history, &c.: in this sense the study of antiquities leads us to inquire into the origin and early epochas of every nation and people, whether ancient or modern. Hence the study of antiquities, as a science, has become, in almost every civilized country, an interesting pursuit to men of leisure and curiosity. By many persons it has been sufficient to investigate the ancient remains of Greece and Rome; but others, who have taken a more enlarged, and, what we deem, a more proper view of the subject, include in the science the antiquities of the Jews, Egyptians, Phœnicians, Carthaginians, and, in short, all those principal nations mentioned in ancient history. Our view of the subject must necessarily be contracted, and the most we can aim at is, to excite a laudable curiosity in the young, and to direct them to objects that may engage their attention, and to the authors most likely to furnish information under the several heads of inquiry and research.

This study has for its chief objects the ceremonies, customs, and usages, which obtained in ancient times, either with regard to persons, places, or things. Writers have accordingly divided antiquities into civil and ecclesiastisal; including under the former head whatever relates to political, military, literary, and domestic concerns; and under the latter, the subjects connected with religion, as the worship, discipline, and faith of ancient times and people. Christians have usually

separated their antiquities into those which relate to the ancient state of the Christian church; and into whatever belongs to the ancient laws, ceremonies, events, &c. that occur in the scriptures. These, indeed, form a branch of ecclesiastical antiquities, and bear a near relation to the Jewish antiquities, concerning which we have many respectable authorities. There are persons who would deduce most of the heathen antiquities from the manners and customs described in the Bible; while others, as Spencer, take the opposite course, and deduce the antiquities of the Bible from those of heathenism. Perhaps a middle course would be nearer the truth, as it is absolutely necessary, in interpreting scripture, to attend to the heathen antiquities alluded to in them; and these not only such as are directly aimed at or approved, but also such as are purposely opposed. National antiquities are those employed in tracing the origin, ancient actions, usages, monuments, remains, &c. of some nation or people: and it may be observed, that almost every nation lays claim to a greater degree of antiquity than the rest of its neighbours. The Scythians, the Phrygians, the Chaldeans, Egyptians, Greeks, Chinese, &c. pretend each to have the honour of being the first inhabitants of the earth: several of these nations, lest they should be surpassed in their pretensions by any of the rest, have traced up their origin to ages long before the received account of the creation. Hence the appellations, "aborigines," "indigenæ," "terrægenæ," "antelunares," &c.

The history and antiquities of nations and societies have been objects of inquiry: inasmuch as they enable the mind to separate truth from falsehood, and tradition from evidence; to establish what had probability for its basis, or to explode what rested only on the vanity of the inventors and propagators: of this we have a striking instance in the Chaldeans, who pretend to astronomical observations of nearly 500,000 years. They mention the king who reigned over them at the time of the deluge, and attribute to him several things which we ascribe to Noah. The Chaldaic antiquities of Berosus are, however, lost, except a few fragments, which have been collected by Joseph Scaliger and Fabricius. To supply the chasm, Annius Viterbo, a Dominican monk, towards the close of the 15th century, forged the work of Berosus, which he published at Rome in 1498. He went farther, and produced a supplement to Berosus, supposed to have been written by Manetho, containing details of what happened from the time of Ægyptus, king of Egypt, to the origin of the Roman state. Unfortunately for the credit of the industrious monk, Manetho lived before Berosus, by which the fraud was detected.

The first traces of every history were rude and imperfect, which renders the office of the antiquarian of the utmost importance to the faithful and diligent historian. Better methods of preserving facts succeeded. The unchsiseled stone, or the rudest hieroglyphic, accompanied the songs of the bards, to perpetuate the achievements of a whole nation, or a few individuals; till the use of letters, and the complicated transactions, claims, and interests of men, taught them to multiply memorials, and draw them up with more skill and accuracy.

The history contained in the Old Testament is unquestionably the most ancient well-authenticated collection of facts, that has come down to the present times. These records go much beyond the flood, the boundary to the annals of every other nation that lays a just claim to credit. The Jews, who are closely connected with this part of history, trace back their ancestry to the common parents of the human race. The antiquities of this wonderful nation have been treated of by numerous writers, whose works are monuments of great learning and indefatigable industry; and it will be admitted, that the fate of a people scattered over the globe, who have been subject to persecutions, more or less severe, for so many centuries, who have never amalgamated, if we may so speak, with any other nation under heaven, but have remained distinct, for wise and important ends, cannot but interest the curious inquirer. The history of their origin, ordinances, and vicissitudes, previously to the Christian æra, is to be had in the Old Testament: their subsequent ruin and dispersion are predicted by Christ in the New Testament, and treated of at large by Josephus, who flourished at Rome under Vespasian, Titus, and Domitian, and who published his great work on the Jewish Antiquities during the life and reign of the latter. On the same subject we have a multitude of more modern writers, from Ugolinus' Thesaurus, consisting of more than thirty volumes folio, and comprising all the best works written previously to the middle of the last century, to the octavos Dr. Jennings evidently intended as a mere introduction to the subject. The antiquities

of the Jews are supposed to be connected with those of Egypt, since Moses, their great lawgiver, was educated in the schools of Egyptian learning, and was deeply conversant in all their sciences. Many of the metaphors and other allusions, found in the first five books of the Bible, are supposed to have some reference to the symbols of the Egyptian priests. If we were, therefore, able to come at a faithful account of the antiquities of Egypt, we might hope to attain an illustration of many things which are still obscure and dark, belonging to the Jewish economy, both civil and sacred. Of Egypt, alas! once renowned for its laws, the commerce of her cities, the grandeur of her buildings, and the fertility of territory, little is left to gratify the laudable curiosity of moderns. Those who have spent much time and labour, in appreciating the worth and merits of the ancients, admit that the earliest nations of the world were fed with the produce of Egyptian soil, and enriched with the wealth and wisdom obtained in that portion of Africa. Upper Egypt furnished the materials of marble and porphyry, with which the most supendous works of art were reared: and to Hermes Trismegistus, or, as he is sometimes called, Thoth, are ascribed, among the Egyptians, the inventions of chief use in human life. Their priests maintained, that from their hieroglyphic characters upon the pillars which he erected, and the sacred books, all the philosophy and learning of the world has been derived.

Egypt seems itself to have been indebted for its original population to the northern parts of Arabia and Syria, the Egyptians and Abyssinians having been always wholly distinct from the native nations of Africa. The Copts, or original inhabitants, it has been observed by travellers, have no resemblance whatever of the negro features or form; but a strong likeness may be traced between the make of the visage in the modern Copts, and that presented in the ancient mummies, paintings, and statues. Their complexion, like that of the Arabs, is of a dusky brown. It is represented of the same colour in the paintings which may be seen in the tombs of Thebes. The chief antiquities are, the pyramids, and the tombs near Thebes, recently disclosed, with many ruins of temples, and other remains of ancient cities. Dr. White, in the "Egyptiaca," a work which contains much valuable information on the subject, says, the celebrated column ascribed to Pompey ornamented a space opposite the temple of Serapis, in which was a great public library. Besides the ancient remains already noticed, we may mention the colossal sphynx; Cleopatra's needle; the marble Sarcophagus, reputed to be Alexander's tomb; and the triple inscription from Rosetta, in the hieroglyphic, the vernacular Egyptian, and the Greek characters. The writers on Egyptian antiquities are very numerous. Among the ancients may be noted, Herodotus, Pausanias, Strabo, Diodorus Siculus, and Plutarch. Herodotus, Thales, and Pythagoras, were initiated into all the mysteries of the Egyptian priests. The mythology of the country is fully explained in Joblonski's "Pantheon Egyptiacum." On the Egypt of modern times we have the works of Pocock, Niebuhr, Sonnini, and Denon, which may be consulted with advantage. Greaves and Nordon have written on the pyramids, and the mummies are described by the celebrated Kircher.

The illustration of the antiquities of India is more difficult, but discoveries are still making in that vast extent of country. To that great patriot, philosopher, and legislator, Sir William Jones, we are greatly indebted for much valuable information on this subject. Mr. Halhed, indeed, in 1776, gave the first specimen which appeared of the early wisdom of the Indians, and their extensive skill in jurisprudence. In the year 1785, the Bhagvat Geeta was edited by Mr. Wilkins. The theological and metaphysical doctrines of this work were represented to be of the profoundest kind, and it was said to contain all the grand mysteries of the Hindoo religion, and laid claim to the antiquity of 4000 years. Other works of high reputation have succeeded; among these are the "Indian Antiquities," by Maurice, which have, in a great measure, cleared the ground for the student, and given him a sort of clue for farther investigations. By his labours, the ancient geographical divisions of India, according to the classical writers of Greece and Rome, and of Hindostan, according to the Hindoos themselves, are reconciled; the analogies of the Brahmanic with other systems of theology considered, and the grand code of civil laws, the original form of government, and the literature of Hindostan, are compared with the laws, government, and literature of Persia, Egypt, and Greece. From Sir William Jones's papers, published in the several volumes of the "Asiatic Researches," much solid information on Indian antiquities may be

had in a short compass. By that great man, whose loss cannot be sufficiently lamented, a society was formed for inquiring into the history, antiquities, arts, sciences, and literature of Asia. Having founded the institution, he gave it celebrity by his own admirable discourses; of these the first was on the orthography of Asiatic words in Roman letters, a want of attention to which had occasioned much confusion in history and geography. Not contented with pointing out radical defects, he proposed a system, which was useful to the learned, and essential to the progress of the student. His other dissertations, to which the reader may be referred, were all, in a greater or less degree, connected with the antiquities of India. By India is meant the whole extent of country in which the primitive religion and language of the Hindoos prevail at this day, and in which the Nægari letters are still used, with more or less deviation from their original form. Its inhabitants have no resemblance, either in their figure or manners, to any of the nations contiguous to them. Their sources of wealth are still abundant. In their manufactures of cotton they surpass the other nations of the world; and though now degenerate and abased, there remains enough to show, that in some early age they were well versed in arts and arms, happy in government, wise in legislation, and eminent in various branches of knowledge.

In this place we may briefly notice the Sanscrit language, which, whatever may be its antiquity, is of a very singular structure; more perfect than the Greek, more copious than the Latin, and more refined than either, yet bearing to both a stronger affinity, both in the roots of verbs, and in the forms of grammar, than could possibly have been produced by accident. Of their philosophy it has been observed, that in the more retired scenes, in groves, and in seminaries of learning, we may perceive the Brahmans and the Sarmanas of Clemans disputing in the forms of logic, or discoursing on the vanity of human enjoyments, on the immortality of the soul, her emanation from the eternal mind, her debasement, wanderings, and final union with her source.

The ancient monuments of Hindostan are very numerous, and of various descriptions, exclusive of the tombs and other edifices of the Mahometan conquerors. Some of the most remarkable are, excavated temples, statues, relievos, &c. in an island near Bombay; but the most magnificent and extensive are near the town of Ellora, about two hundred miles east of Bombay. The latter are minutely described, and illustrated with plates, in the sixth volume of the Asiatic Researches. The idols represented seem clearly to belong to the present mythology of Hindostan: but at what period these edifices were modelled, whether three hundred or three thousand years ago, cannot be easily ascertained. Several ancient grants of land, some coins, and seals, have also been found, which, however, do not greatly correspond with the exaggerated ideas entertained concerning the early civilization of this renowned country; while the Egyptain pyramids, temples, and obelisks, strongly confirm the accounts preserved by ancient historians. Though the mythology of the Hindoos may pretend to great antiquity, yet their present form of religion is supposed to vary considerably from the ancient. It is inferred, that while the religion of Boodha, still retained by the Birmans and other adjacent nations, was the real ancient system of Hindostan, the religion of the Hindoos is artfully interwoven with the common offices of life; and the different casts are supposed to originate from Brahma, the immediate agent of creation, under the Supreme Power.

The remains of architecture and sculpture seem to prove an early connection between India and Africa. Of the ancient arts and manufactures little is known, excepting the labours of the Indian loom and needle. The Hindoos are said to have boasted of three inventions, *viz.* the method of instruction by "apologues," "the decimal scale," and "the game of chess"

Of the antiquities of Greece and Rome much has been written that merits the attention of the student in literature: these are subjects, in which every well educated youth is made conversant at an early period. They are taught in all our classical schools, as necessary to the elucidation of those works that are read in the attainment of the ancient languages. Potter on the Greek antiquities, and Kennet and Adams on those of Roman, are familiar to every ear: in their kind they are truly respectable, though they may be regarded only as elementary treatises, calculated rather to excite a taste for the study, than to satisfy the inquirer in pursuit of knowledge.

The first accounts of Greece are derived from ages long before the common use of letters in the country, so that it is difficult

to distinguish where fable concludes, and real history begins. From the Phœnician and Egyptian colonies, the Greeks first received the culture of humanity. By the Phœnicians, they were instructed in trade, navigation, and the use of letters; and by the Egyptians in civil wisdom, the politer sciences, and religious mysteries. The antiquities of such a country, which became in after ages so illustrious in the annals of mankind, cannot fail to have excited a considerable degree of interest in every age: they have accordingly been carefully and minutely investigated, by writers celebrated alike for their erudition and industry. Of these we can enumerate but a small portion, in comparison of the many that have treated on the subject. Bishop Potter, to whom we have already referred, Bos, and others, have drawn up systems or abridgments of the whole, or at least of whatever relates to the religion, the gods, the vows, and the temples of Greece: on the public weal and magistracy, Stephanus and Van Dale are well worthy of notice: on the laws and punishments of Greece, we have Meursius and Petit: on military concerns, Arrian and Ælian are well known: on their gymnastic art, and exercises, Joubert and Faber may be mentioned: on the theatres and scenic exhibitions, Scaliger and the abbe Barthelemy have written: besides these, we have many writers on their entertainments, on their marriages, the education of their children, and their funeral ceremonies. The best relics, which display the former splendour of the Grecian states, have been preserved by Stuart in his Athens: in the Ionian Antiquities, and in the Voyage Pittoresque de la Greece. The finest specimens of its sculpture, in this country, are to be found among the Townly marbles: and of its coinage, in the cabinet of Dr. Hunter.

It may be worthy of notice, in connection with the antiquities of Greece, that the ancient monuments of European Turkey now exceed in number and importance those of any other country. The remains of ancient Athens, in particular, formerly the chosen seat of the arts, have attracted the attention of many travellers, and have accordingly been frequently described with accuracy and taste. The church dedicated to the Divine Wisdom, usually denominated in the page of history Sancta Sophia, is a venerable monument of antiquity, and has been preserved from the sixth century, when it was built by Justinian, to the present period. The architecture is very inferior to that of the classical period, yet, by those who have witnessed it, we are told the effect is grand and impressive, and the cupola is admired as a bold and skilful effort of the art, while the seeming weight is diminished by the lightness of the materials, being bricks formed of a particular clay that will float in the water. The interior is adorned with columns of various and very beautiful descriptions, *viz.* the Phrygian purple, the Spartan green, the red and white Canan, and many others. To this may be added, that the French have recently discovered the remains of an ancient sea-port belonging to Sparta, near a promontory which projects from the south of the Morea, and we are informed that the antiquities of that part, now styled Albania, still present an extensive field of research to the student in this department of science.

"Nothing," says Dr. Adams, in the preface to his Roman Antiquities, "has more engaged the attention of literary men, than to trace from ancient monuments the institutions and laws, the religion, the manners and customs of the Romans, under the general name of Roman Antiquities. This branch of knowledge," continues he, "is not only curious in itself, but absolutely necessary for the understanding the classics, and for reading with advantage the history of that celebrated people. It is particularly necessary for such as prosecute the study of the civil law. Scarcely on any subject have more books been written, and many of them by persons of distinguished abilities." We may, as a guide to the student, enumerate the writers from whom Dr. Adams chiefly compiled his own work, as these will be the best authorities for those persons who would enter deeply into the study. To Manutius, Brissonius, and Middleton, he was indebted for his facts relating to the business of the senate: to Pignorius, on slaves: to Lidonius and Grucchius, Manutius, Huber, Gravina, Murula, Heineccius, for what relates to the assemblies of the people, the rights of citizens, the laws and judicial proceedings: with respect to the duties and privileges of magistrates, the art of war, the shows of the circus, and the feats of gladiators, he had recourse to Lipsius:—to Sheffer he applied for information on naval affairs, and carriages: to Kermannus, on funerals: to Arbuthnot, on coins: to Donatus, on the city: to Turnebus, Salmasius, Grævius, Gronovius, Montfaucon, Gesner, and others, upon different subjects scattered through his work. To these may be added one of the

oldest authors on the subject, *viz.* Dionysius Halicarnassus, who traced the origin of the Romans, with great fidelity, back to the remotest ages. His accounts are generally preferred to those of Livy, because they are more ample, and his facts are described with more particulars; and on the ceremonies, worship, sacrifices, manners, customs, discipline, policy, courts, laws, &c. he is perhaps the most authentic writer.

These, and other authors that might be cited, have chiefly confined their account to Rome, properly so called; we might digress, and notice the antiquities of those states, both in Europe and other parts of the globe, which were held under the dominion of the Roman power; but this would lead us into a very wide field: we shall, however, in the connection, notice those belonging to Spain, which was 500 years under the Roman power.

Spain was originally peopled by the Africans and German Gauls: it then became the prey of the Carthagenians: to these succeeded the Romans. It was afterwards held successively in subjection by the Vandals, the Visigoths, and the Arabs or Moors.

Of the first of these epochs few remains exist, excepting some tumuli, and other rude monuments. Nor are there any certain relics of the Carthagenians in Spain but coins, which have been found in considerable numbers. The Roman antiquities are numerous, of which, however, we shall notice but few. The aqueduct at Segovia is a noble edifice, consisting of 159 arches, extending about 740 yards, and is rather more than 94 feet in height where it crosses the valley. Morviedo, the ancient Saguntum, and Tarragona, the ancient Tarraco, afford many curious remains of antiquity. The theatre is capable of receiving 10,000 people, and is hewn out of a solid rock, the labour of which was less than might at first be expected, as the Spanish rocks are generally calcareous, or of gypsum. The Visigoth kings have left few relics except their coins, which are struck in gold, a metal at that period unknown to the other European mints. Numerous and splendid are the monuments of the Moors in Spain. The mosque at Cordova is one of the chief; this surprizes travellers with the multitude of its columns, which are said to be 800. The Christian antiquities here, as in other places, are, churches, castles, and monasteries.

The antiquities of Portugal consist also chiefly of Roman monuments, with some Moorish remains. In the north is an extensive series of arches, formerly a Roman aqueduct. At Evora are well-preserved ruins of a temple of Diana, and an aqueduct ascribed to Quintus Sertorius, whose life was written by Plutarch. Among the antiquities of the middle ages may be noted the monastery of Batalha, in Estremadura, 60 miles north of Lisbon, which is allowed on all hands to be one of the noblest monuments of what is called the Gothic style of architecture.

English antiquities fall into the following divisions, *viz.* those belonging to the primitive Celtic inhabitants; those of the Belgic colonies; those of the Romans; those of the Saxons; reliques of the Danes; and, lastly, Norman monuments. Few of these remains are thought to throw much light upon the history of the country; but, being interesting and curious in themselves, they may, in this article, which is intended as a guide to the study, be briefly noticed. A radical mistake, according to Mr. Pinkerton, in the study of English antiquities, has arisen from the confusion of the Celtic and Belgic languages and monuments. The Druids have deservedly attracted much curiosity and research; but it would be erroneous to impute to them, as is usual, the whole of our earliest remains. Cæsar speaks of Druidism as a recent institution; and if that be the case, it is not improbable that it originated from the Phœnician factories, established in wooden fortresses, the usual practice of commercial nations when trading with savage or barbarous people. The tenets correspond with what little exists of Phœnician mythology, and the missionaries of that refined people might have some zeal in their diffusion. Ancient authors, who give us all our information concerning the Druids, minutely describe their religious rights, but are totally silent concerning any monuments of stone being used among them. On the contrary, they mention gloomy groves and spreading oaks as the only scenes of the Druidic ceremonies; nevertheless, antiquaries have inferred that Stonehenge is a Druidic monument, though it be situated in an extensive plain, where not a vestige of wood appears, and where the very soil is reputed to be adverse to its vegetation. It would be a vain effort to attempt to discriminate the remains of the earliest inhabitants from those of the Druidic period, and if the opinion of the last-mentioned author is to be regarded as binding, there is no foundation for any sound or real knowledge on the subject. The following have been esteemed as the monu-

ments of the Druids :—1. Single stones erect. 2. Rock idols and pierced stones. 3. Rocking-stones, used as ordeals. 4. Sepulchres of two, three, or more stones. 5. Circular temples, or rather circles of erect stones. 6 Barrows, or tumuli. 7. Cromlechs, or heaps of stones. 8. Rock-basins, imagined to have been used in Druidic expiations. 9. Caves, used as places of retreat in time of war. But as most of these relics may also be found in Germany and Scandinavia, it is difficult to say whether they are Gothic or Celtic; and as the Germans had no Druids, we cannot, with any degree of certainty, bestow the name of Druidic upon such monuments. It is highly probable, that the earliest inhabitants, as is ever the practice in the infancy of society, made use of wood, not of stone, in their religious as well as in their domestic erections. If we survey the various savage regions of the globe, we shall seldom, if ever, perceive the use of stone; and it is certainly just to infer, that the savages of the west were not more skilful than those of the east, nor those of the old continents and islands than those of the new. But as many of these monuments are found in Germany, Scandinavia and Iceland, and as the Icelandic writers in particular often indicate their origin and use, which are unknown in the Celtic records, there is every reason to attribute them to a more advanced stage of society, when the Belgic colonies introduced agriculture, and a little further progress in the rude arts of barbarism. The nature of this work will not admit a formal investigation of such topics, but a few remarks may be offered on Stonehenge, a stupendous monument of barbaric industry. Inigo Jones, in attempting to prove that it is Roman, only evinces that no talents can avail when science is wanting, and that antiquities require a severe and peculiar train of study. Doctor Stukely, a visionary writer, assigns Stonehenge to the Druids; while Dr. Charlton, perceiving that such monuments are found in Denmark, ascribed it to the Danes. If the latter had considered, that the Belgæ were a Gothic nation, of similar language and institutions, he might with more justice have extended his antiquity. From the Icelandic writers we learn, that such circles were called *domh-ringr*, that is literally doom-ring, or circle of judgment, being the solemn places where courts were held, of all kinds and dignities, from the national council down to the baronial court, or that of a common proprietor of land, for adjusting disputes between his villani and slaves. The magnificence of Stonehenge loudly pronounces that it was the supreme court of the nation, equivalent to the Champs de Mars et de Mai of the Franks, where the king and chiefs assembled in the circle, and the men capable of arms in the open plain; nor is it improbable that the chiefs ascended the transverse stones, and declared their resolves to the surrounding crowd, who, in the description of Tacitus, dissented by loud murmurs, or applauded by clashing their shields. This idea receives confirmation from the circumstance, that the Belgæ, peculiarly so called, as being the chief and ruling colony of that people, were seated in the surrounding province, and Sorbiodunum, now Old Sarum, was their capital city. Similar circles of stone, but far inferior in size, are found in many parts of Great Britain and Ireland, and several undoubtedly as late as the Danish inroads and usurpations, the practice being continued by that people at least till their conversion to Christianity, in the tenth and eleventh centuries. Some of the smallest, as we learn from the northern antiquaries, were merely places of family sepulture. At a later period, the circles of judgment, which had been polluted with human sacrifices and other Pagan rites, were abandoned, and the great courts were held on what were called moot-hills, or hills of meeting, many of which still exist in the British dominions and in the Netherlands. They commonly consist of a central eminence, on which sat the judge and his assistants; beneath was an elevated platform for the parties, their friends and compurgators, who sometimes amounted to a hundred or more; and this platform was surrounded with a trench, to secure it from the access of the mere spectators. Of the other monuments of this period a more brief consideration must suffice. When a monarch or distinguished general was buried, a barrow or hillock was erected, to preserve his name and memory to future ages; the size depending on the reputation of the person, which attracted a smaller or larger number of operators. Such monuments are very ancient, and even to this day denote the sepulchres of some of the heroes of the Trojan war. In later times, a large single stone erected was esteemed a sufficient memorial: such single stones also sometimes appear as monuments of remarkable battles, or merely as boundaries. The caves are familiar to most nations in an early state of society. The Belgic reliques are followed by those of the Romans, which are mostly objects of mere curiosity, and rarely throw the smallest light on the page

of history. Amphitheatres are said to be still visible at Silchester, in Hampshire, and some other places. The Roman castle at Richborough, the ancient Rutupiæ, in Kent, presents considerable remains of a massy wall cemented with surprising firmness. The Roman ruins in this country are commonly composed of stone or flint, with strata of flat bricks at considerable intervals. The Mosaic pavements, hypocausts, &c. are generally the remains of the villas of opulent Romans, scattered over the country. The greatest number of Roman inscriptions, altars, &c. has been found in the north, along the great frontier wall, which extended from the western sea to the estuary of the Tyne. This vast wall is justly esteemed the most important remain of the Roman power in England, as that of Antoninus is in Scotland. The extent was about 70 miles, and its construction, forts, &c. have been illustrated by the labour of several antiquaries. Numerous are the more minute relics of the Romans in England, as coins, gems, weapons, ornaments, and the like; among which, however, the silver dish belonging to the Duke of Northumberland deserves especial mention. One of the grand causes of the civilization introduced by that ruling people into the conquered states was the highways, which form, indeed, the first germ of national industry, and without which neither commerce nor society can make any considerable progress. Conscious of this truth, the Romans seem to have lent particular attention to the construction of roads in the distant provinces; and those of England, which may still be traced in various ramifications, present a lasting monument of the justice of their conceptions, the extent of their views, and the utility of their power. A grand trunk, as it may be called, passed from the south to the north, and another to the west, with branches, in almost every direction that general convenience and expedition could require. What is called the Watling-street, led from Richborough, in Kent, the ancient Rutupiæ, N. W. through London to Chester. The Ermin-street passed from London to Lincoln, thence to Carlisle, and into Scotland, the name being supposed to be corrupted from Herman, which means warrior, as the chief wars lay in the north. The Fosse Way is supposed to have led from Bath and the western regions, N. E. till it joined the Ermin-street. The last celebrated road was the Ikenild, or Ikneld, supposed to have extended from near Norwich, S. W. into Dorsetshire. The Saxon antiquities in England are chiefly edifices, sacred or secular; many churches remain, which were altogether, or for the most part, constructed in the Saxon period, and some are extant of the tenth, or perhaps the ninth century. The vaults erected by Grimbald, at Oxford, in the reign of Alfred, are justly esteemed curious relics of Saxon architecture. Mr. King has ably illustrated the remains of the Saxon castles. The oldest seem to consist of one solitary tower, square or hexagonal: one of the rudest specimens is Coningsburg Castle, in Yorkshire; but as that region was subject to the Danes till the middle of the tenth century, it is probably Danish. Among the smaller remains of Saxon art may be mentioned, the shrines for preserving relics, which some suppose to present the diminutive rudiments of what is styled the Gothic architecture; and the illuminated manuscripts, which often afford curious memorials of the state of manners and knowledge. The Danish power in England, though of considerable duration in the north, was in the south brief and transitory. The camps of that nation were circular, like those of the Belgæ and Saxons, while those of Roman armies are known by the square form: and it is believed that the only distinct relics of the Danes are some castles to the north of the Humber, and a few stones with Runic inscriptions. The monuments styled Norman, rather to distinguish their epoch than from any information that Norman architects were employed, are reputed to commence after the conquest, and to extend to the fourteenth century, when what is called the rich Gothic began to appear, which in the sixteenth century was supplanted by the mixed, and this in its turn yielded to the Grecian. In general, the Norman style far exceeds the Saxon in the size of the edifices, and the decoration of the parts. The churches become more extensive and lofty, and though the windows retain the circular arch, they are larger and more diversified; the circular doors are festooned with more freedom and elegance; and uncouth animals begin to yield to wreaths of leaves and flowers. The solitary keep, or tower, of the Saxon castle is surrounded with a double wall, inclosing courts and dwellings of large extent, defended by turrets and double ditches, with a separate watch-tower called the Barbican. Among others, the cathedrals of Durham and Winchester may be mentioned as venerable monu-

ments of Anglo-Norman architecture; and the castles are numerous and well known. What is called the Gothic, or pointed arch, is generally supposed to have first appeared in the thirteenth century, and in the next it became universal in religious edifices. The windows diffused to great breadth and loftiness, and divided into branching interstices, enriched with painted glass; the clustering pillars, of excessive height, spreading into various fret-work on the roof, constitute, with decorations of smaller note, what is called the rich Gothic style, visible in the chapel of King's college at Cambridge, and many other grand specimens in this kingdom. The spire corresponds with the interior, and begins about the thirteenth century to rise boldly from the ancient tower, and diminish from the sight in a gradation of pinnacles and ornaments.

We now proceed to Scotland, the original population of which is supposed upon good authority to consist of Cimbri, from the Cimbric Chersonese. About two centuries before the Christian æra, the Cimbri seem to have been driven to the south of Scotland by the Caledonians, or Picti, a Gothic colony from Norway. The Cimbri, a congenerous people with the Welch, continued to hold the country south of the two firths of Forth and Clyde; but from the former region they were soon expelled by the Picti, who, in this corner, became subject for a time to the Anglo-Saxon kings of Bernicia. On the West, the Cumraig kingdom of Strath Clyde continued till the tenth century, when it became subject to the kings of North Britain; who at the same time extended their authority, by the permission of the English monarch, over the counties of Cumberland and Westmoreland, which, abounding with hills and fortresses on the south and east, were little accessible to the English power, and, while the Danes possessed the country to the north of Humber, could yield little revenue or support to the Anglo-Saxon monarchs. From the Picti originates the population of the Lowlands of Scotland, the Lowlanders having been in all ages a distinct people from those of the western Highlands, though the Irish clergy endeavoured to render their language, which was the most smooth and cultivated of the two, the polite dialogue of the court and superior classes. About the year of Christ 258, the Dalriads of Bede, the Attacotti of the Roman writers, passed from Ireland to Argyleshire, and became the germ of the Scottish Highlanders, who speak the Irish or Celtic language, while the Lowlanders have always used the Scandinavian or Gothic. In reference to the antiquities of the country, Mr. Pinkerton divides the early history into seven distinct periods, *viz.* 1. The original population of Scotland by the Cimbri, and by the Picti. 2. The entrance of Agricola into Scotland, and the subsequent conflicts with the Romans, till the latter abandoned Britain. 3. The Settlement of the Dalriads or Attacotti, in Argyleshire, about the year 258, and their repulsion to Ireland about the middle of the fifth century. 4. The commencement of what may be called a regular history of Scotland, from the reign of Drust, A. D. 414. 5. The return of the Dalraids, A. D. 503, and the subsequent events of Dalriadic story. 6. The introduction of Christianity among the Caledonians, in the reign of Brudi II. A. D. 565. 7. The union of the Picti and Attacotti, under Kenneth, A. D. 843, after which greater civilization began to take place, and the history becomes more authentic. The monuments of antiquity belonging to these epochs may be considered in the following order. Of the first epoch, no monuments can exist except those of the tumular kind; and it is impossible to ascertain the period of their formation. The remains of the Roman period in North Britain chiefly appear in the celebrated wall built in the reign of Antoninus Pius, between the firths of Forth and Clyde, in the ruins of which many curious inscriptions have been found. Another striking object of this epoch was a small edifice, vulgarly called Arthur's oven, which seems rightly to have been regarded by some antiquaries as a small temple dedicated to the god Terminus, probably after the erection of the wall of Antoninus, for we are not to conceive these walls were the absolute lines beyond which the Romans possessed no territory; while, on the contrary, in the pacific intervals, the garrisons along the wall may have claimed the forage of the exterior fields; and the stream of Carron, beyond which this chapel stood, may have been considered as a necessary supply of water. The remains of the wall and forts, and other Roman antiquities, in Scotland, particularly their camps and stations, many of which are remarkably entire, are ably illustrated in a late publication of General Roy; but the ingenious author has perhaps too implicitly followed a common antiquarian error, in ascribing all these camps, stations, &c. to Agricola,

while they may be more justly assigned to Lollius Urbicus, A. D. 140, or to the Emperor Severus, A. D. 207, especially indeed to the latter; for the Emperor's appearance, in person, to conduct two campaigns, probably as far as Inverness, must have occasioned the erection of works more eminent and durable than usual, the soldiers being excited by the animating controul of a military monarch. Constantius Chlorus also, A. D. 306, made a long progress into Scotland, if we trust the panegyrists. Nay, in the reign of Domitian, Bolanus, as we learn from Statius the poet, erected several works in Britain, probably in the north; so that it is idle to impute these remains to any one author; but to a judicious eye, the claims of Lollius Urbicus, and of Severus, seem preferable. The most northerly Roman camp, yet discovered, is that near the source of the river Ythan, Aberdeenshire; periphery about two English miles. A smaller station has also been observed at Old Meldrum, a few miles to the S. E. Roman roads have been traced a considerble way in the east of Scotland, as far as the county of Angus, affording some evidence of the existence of the province of Vespasiana; but the chief remains are within the wall. A hypocaust was also discovered near Perth, and another near Musselburg, so that there was probably some Roman station near the Scotish capital. The smaller remains of Roman antiquity found in Scotland, as coins, utensils, &c. are numerous. With the fourth epoch may be said to commence the Pikish monuments of antiquity. The tombs it would be difficult to discriminate from those of the first epoch; but as the Caledonian kings, when converted to Christianity, held their chief residence at Inverness, the singular hill in its vicinity, presenting the form of a boat reversed, may, perhaps, be a monument of regal sepulture. The places of judgment among the Gothic nations, or what are now styled Druidic temples, are numerous; and there is a remarkable one in the Isle of Lewis, where, probably, the monarchs resided in the most early times; but this, perhaps, rather belongs to the Norwegian settlement in the ninth century. Some of these monuments are of small circuit; and such are sometimes found at no great distance from each other; as they were not only sometimes erected merely as temples to Odin, Thor, Freyga, and other Gothic deities, but every chief, or lord of a manor, having jurisdiction over many servants and slaves, such small courts became places of necessary awe. The houses seem to have been entirely of wood or turf; but in some spots singular excavations are found, rudely lined with stone; these are called weems, and it is likely that they were always adjacent to the wooden residence of some chief, and were intended as depositories of stores, &c. the roofs being too low for comfortable places of refuge. The stations and camps of the natives are distinguished by their round form, while those of the Romans belong to the square. Under the next epoch it would be difficult to discover any genuine remains of the Dalriads. The houses, and even the churches were constructed in wattle work; and the funeral monuments were cairns or heaps of stones. It is probable that Christianity did not immediately dissolve ancient prejudices, and that even the Atticottic kings were buried in this rude manner; for the genuine chronicles do not affirm that they were conveyed to Hyona or Icolmkill; and the sepulchres there shewn, of Irish and Norwegian kings, must be equally fabulous. To the sixth epoch may probably belong a chapel or two, still remaining in Scotland, for Bede informs us that Nethan III. A. D. 715, obtained architects from Ceolfrid, abbot of Jarrow and Weremouth, to build a church in his dominions, probably at Abernethy; but the round tower there remaining seems of more recent origin. About the year 830, Ungust II. founded the church of St. Andrew; and the chapel called that of St. Regulus, (who seems unknown in the Roman calendar) may, perhaps, claim even this antiquity. It is probable, that these sacred edifices in stone were soon followed by the erection of those rude round piles, without any cement, called Piks-houses; yet they may more properly belong to the seventh epoch, when the Danes may share in the honour of the erection, for such edifices have been traced in Scandinavia. They seem to have consisted of a vast hall, open to the sky in the centre, while the cavities in the wall present incommodious recesses for beds, &c. These buildings are remarkable, as displaying the first elements of the Gothic castle; and the castle of Coningsburg in Yorkshire forms an easy transition. The engraved obelisks found in Forres, and in other parts of Scotland, have been ascribed to the Danish ravagers, who had not time for such erections. They are, probably, monuments of signal events, raised by the king or chiefs; and as some are found in Scandinavia, as

recent as the fifteenth century, it is probable that many of the Scottish obelisks are far more modern than is generally imagined.

We are next to consider the antiquities of Ireland. The original population of this country passed from Gaul, and was afterwards increased by their brethren the Guydil from England. About the time that the Belgæ seized on the south of England, it appears that kindred Gothic tribes passed to the south of Ireland. These are the Firbolg of the Irish traditions, and appear to have been the same people whom the Romans denominated Scoti, after they had emerged to their notice, by not only extending their conquest to the north and east in Ireland, but had begun to make maritime excursions against the Roman provinces in Britain. But Ireland had been so much crowded with Celtic tribes, expelled from the continent and Britain, by the progress of the German Goths, that the Belgæ almost lost their native speech and distinct character; and from intermarriages, &c. became little distinguishable from the original population, except by superior ferocity, for which the Scoti, or those who affected a descent from the Gothic colonies, were remarkable, while the original Gael seem to have been an innocent and harmless people. The epochs in Ireland, to which its antiquities are referrable, are the following: 1. The first historical epoch of Ireland is its original population by the Celtic Gauls, and the subsequent colonization by the Belgæ. 2. The maritime excursions of the Scoti against the Roman provinces in Britain. 3. The conversion of Ireland to Christianity in the fifth century which was followed by a singular effect; for while the mass of the people retained all the ferocity of savage manners, the monastaries produced many men of such piety and learning, that Scotia or Ireland became celebraed all over Christendom. 4. This lustre was diminished by the ravages of the Scandinavians, which began with the ninth century, and can hardly be said to have ceased when the English settlement commenced. The island had been split into numerous principalities, or kingdoms, as they were styled; and though a chief monarch was acknowledged, yet his power was seldom efficient, and the constant dissensions of so many small tribes rendered the island an easy prey. 5. In the year 1170 Henry II. permitted Richard Strongbow, earl of Pembroke, to effect a settlement in Ireland, which laid the foundation of the English possessions in that country. There are however coins of Canute, king of England, struck at Dublin, perhaps in acknowledgement of his power, by the Danish settlers. After this period Ireland became, in some measure, a commercial country, and her history is to be looked for in that of England, with which it is interwoven. Upon a review of the more ancient of these historical epochs, and of the monuments which may be considered as belonging to each, it must be considered, that the edifices having been constructed of wood till the eleventh or twelfth century, it cannot be expected that any remains of them should exist. Stone was chiefly employed in the construction of funeral erections of various kinds; nor are barrows wanting in Ireland, being hillocks of earth thrown up in commemoration of the illustrious dead. Other monuments, commonly styled Druidic, may also be found in Ireland; such as single stones erect, circular temples, or rather places of judgment, and the like, which may more properly be ascribed to the Belgic colony. The conversion of Ireland to Christianity was followed by the erection of a vast number of churches and monasteries, the latter being computed to exceed one thousand in number; but all these edifices were originally small, and constructed of interwoven withs, or hewn wood; for St. Bernard, in the twelfth century, mentions a stone church as a singular novelty in Ireland. But the Scandinavian chiefs must before this period have introduced the use of stone into the castles, necessary for their own defence against a nation whom they oppressed; and sometimes even subterraneous retreats were deemed expedient, of which Ware and others have engraved specimens. To the Scandinavian period also belong what are called the Danes Raths, or circular intrenchments; and some chapels, such as those of Glendaloch, Portaferry, Killaloe, Saul Abbey, St. Doulach, and Cashel, if we may judge from the singularity of the ornaments, which, however, only afford vague conjecture. But of the round castles, called Duns in Scotland, and of the obelisks engraven with figures or ornaments, few or none exist in Ireland. Under the Scandinavians the Irish coinage first dawns. Of the eleventh and twelfth centuries many monuments castellated or religious, may probably exist in Ireland. Brian Boro, king of Munster, having been declared sovereign of Ireland in the year 1002, he distinguished himself by his virtues and courage; and Dermid III. A. D. 1041—

1073, was also an excellent and powerful prince. Under these monarchs, and their successors, Terdalvac and Moriertac, the power of the Scandinavians was considerably weakened. The native chiefs had been taught the necessity of fortresses, and were generally devoutly attached to religion; it is therefore to be inferred, that many castles, churches, and monasteries, now began to be partly constructed in stone, by architects invited from France and England; but perhaps the round towers were erected by native builders. Among smaller relics of antiquity, the golden trinkets found in a bog near Cullen, in the south, deserve mention: as gold was found in Gaul, they are perhaps ornaments of the ancient chiefs, brought from that region.

It remains now to mention the names of some of those authors who have written on the antiquities of our own country. Tacitus was an eye-witness to the ceremonies of Druidism in England, as the Romans were in Wales. To him, to Cæsar already referred to, and to Dio Cassius, we refer, as the chief authorities in regard to British history. To these may be added Ælian, Diodorus Siculus, Strabo, and Pliny. Cluverius, Pezron, and Pelloutier, are more modern, but respectable, writers on the same subject. Of the structures erected by the Britons, Abury and Stonehenge may be deemed the principal. Relics of a smaller kind are continually discovered a few feet beneath the surface of the earth. On these Stukely and Rowland are the best authorities: the former has written a volume on Abury, a temple of the Druids, in which is a particular account of the first and patriarchal religion, and of the peopling of the British islands: besides his larger work, entitled "Itinerarium Curiosum," being an account of the antiquities, &c. observed in travels through Great Britain, published in 1724. For the history of the Britons under the Roman Government, Horsley's Brit. Rom. is a work that may be depended upon. With respect to the antiquities of the Saxons, the illuminated manuscripts are the best records of their manners in the different centuries, and the most interesting information respecting them has been collected by Turner and Strutt. The best collection of Saxon coins is in the British Museum, and of manuscripts in the same place, and in the Bodleian Library. Mr. King has treated of their military antiquities in his History of Castles; and, independently of our works on topography, which are numerous, and many of them of the first respectability, and which throw considerable light on the antiquities of the country, we may refer to Henry's History of England, where the subject is discussed systematically and in chronological order; and to the works of Camden, Strutt, and Gough, to which may be added the whole series of the Gentleman's Magazine, and Pinkerton's Geography, to which we have been indebted for a part of this article.

As the antiquities of the united kingdom are in some respects connected with those of the Danes and other northern nations, we may suggest to the reader what are the principal remains of those people, as a clue to his future inquiries.

The ancient monuments of Denmark and Norway are chiefly Runic, though it is far from certain at what period the use of Runic characters extended so far north. Circles of upright stones are common in all the Danish dominions, the islands, Norway, and Iceland, in which latter country their origin is perfectly ascertained, as some were erected even in recent times of the Icelandic republic, being called *domh-ring*, or circles of judgment. Some also appear to have been the cemeteries of superior families. Monuments also occur of two upright stones with one across; and of the other forms supposed to be Druidic. The residences of the chiefs appear to have been generally constructed of wood, as there are very few ancient castles existing in Denmark or Norway.

Of Sweden the ancient monuments consist chiefly of judicial circles and other erections of unhewn stone, together with remains inscribed with Runic characters, none of which are imagined to have existed longer than the eleventh century.

In Russia the ancient monuments are neither numerous, nor afford much variety. There are to be met with the tombs of their pagan ancestors, containing weapons and ornaments. From the writings of Herodotus we learn that the Scythians regarded the cemeteries of their princes with singular veneration: the Sarmatians or Slavons seem to have imbibed the same ideas. The catacombs of Kiow, it is believed, were formed in the pagan period, though they are now replete with marks of Christianity. They are labyrinths of considerable extent, dug, as it should seem, through a mass of hardened clay, but they do not appear to contain the bodies of the sovereigns. The idols of Pagan Russia are sometimes found cast in bronze; and Dr. Guthrie has given a good account of the Slavonic mythology, to whose "Dissertations sur les Antiquites de Russie" we refer the reader. We may however observe, that the pagan

Russians worshipped one god, supposed to be the author of thunder; another, that resembled the Pan of the ancients; others, answering to the Sun, Hercules, Mars, Venus, and Cupid. They had also goddesses, corresponding with Ceres, Diana, and Pomona, and their nymphs of the woods and waters. They worshipped Znitch or Vesta in the form of fire, and venerated waters, the Bog being as highly regarded by the ancient Russians as the Ganges among the Indians: the Don and the Danube were also considered as holy streams; and there was a sacred lake, environed with a thick forest, in the isle of Rugen, which was adored by the Slavonic tribes.

Antiquities in the Valley of the Mississippi.

"Considerable curiosity has been excited by appearances on the Mississippi and its tributary waters, supposed to prove a more ancient population, than the state of the country, or the character of the tribes inhabiting it, when first visited by Europeans, would seem to indicate.

"The *American bottom* is a tract of rich alluvian land, extending on the Mississippi, from the Kaskaskia to the Cahokia river, about eighty miles in length and five in breadth; several handsome streams meander through it; the soil of the richest kind, and but little subject to the effects of the Mississippi floods.—If any vestige of ancient population were to be found, this would be the place to look for it.—Accordingly, this tract, as also the bank of the river on the western side, exhibit proofs of an immense population.—If the city of Philadelphia* and its environs were deserted, there would not be more numerous traces of human existence.—The great number of mounds, and the astonishing quantity of human bones, every day dug up, or found on the surface of the ground, with a thousand other appearances, announce that this valley was at one period filled with habitations and villages. The whole face of the bluff, or hill, which abounds to the east, appears to have been a continued burial ground.

"But the most remarkable appearances are, two groups of mounds or pyramids, the one about ten miles above Cahokia, the other nearly the same distance below it, which, in all, exceed one hundred and fifty, of various sizes.—A more minute description of those above Cahokia will give a tolerable idea of them all.—They are mostly of a circular shape, and at a distance resemble enormous haystacks scattered through a meadow. One of the largest is about two hundred paces in circumference at the bottom, the form nearly square. The top level, with an area sufficient to contain several hundred men.

"At the distance of three miles along the bank of the Cahokia there is the largest assemblage—the principal one of which is a stupendous pile of a mass of earth, that must have required years, and the labour of thousands, to accomplish. Were it not for the regularity and design which it manifests, the circumstances of its being on alluvial ground, and the other mounds scattered around, it could scarcely be believed to be the work of human hands.—The shape is that of a parallelogram, standing from north to south; on the south side there is a broad apron, or step, about half way down, and from this, another projection into the plain, about fifteen feet wide, which was probably intended as an ascent to the mound. The circumference at the base is at least eight hundred yards, and the height of the pyramid about ninety feet.

"Several of these mounds are almost conical, and at regular distances from each other; about which are scattered pieces of flint, and fragments of earthen vessels.

"A curious discovery, made a few years ago in the state of Tennessee, proves, beyond a doubt, that at some remote period the valley of the Mississippi had been inhabited by a much more civilized people than when first known to us.—Two human bodies were found in a copperas cave, in a surprizing state of preservation.—They were first wrapped up in a kind of blanket, supposed to have been manufactured of the lint of nettles, afterwards with dressed skins, and then a mat of nearly sixty yards in length. They were clad in a beautiful cloth, interwoven with feathers, such as was manufactured by the Mexicans. They had been here, perhaps, for centuries, and certainly were of a different race from the modern Indians. They might have belonged to the Olmec, who overran Mexico about the seventh century; to the Toultec, who came centuries afterwards; or to the Aztecs, who founded the great city of Mexico about the thirteenth century.

"In tracing the origin of institutions or inventions amongst men, we are apt to forget, that nations, however diversified

* "The Saline, below St. Genevieve, cleared out some time ago, and deepened, was found to contain waggon loads of earthen-ware, some fragments bespeaking vessels as large as a barrel, and proving that the Salines had been worked before they were known to the whites."

by manners and languages, are yet of the same species, and that the same institutions may originate amongst twenty different people. The wonder would be, that they should not shew a resemblance. We find these mounds in every part of the globe; in the north of Europe, and in Great-Britain, they are numerous, and much resemble ours, but less considerable. The pyramids of Egypt are perhaps the oldest monuments of human labour in that country, so favourable to the production of a numerous population. The Pyramids of Mexico, which are but little known, and yet scarcely less considerable, like those of Egypt, have their origin hid in the night of oblivion.

"Who will assign, as the age of America, a period of years different from that allowed to, what has been denominated, the old world? The multiplicity of proofs contradict the recency of her origin; deeply imbedded stories of carbonated wood, the traces of ancient volcanoes! We could appeal to her time-worn cataracts, and channels of mighty rivers, and to her venerable mountains.—Grant, then, that America may have existed a few thousand years; the same causes prevailing, like effects will be produced; the same revolutions as have been known in the old world may have taken place here."*—See *Views of Louisiana*, by H. M. Breckenridge, Esq.

ANTIRRHINUM, *snapdragon, toad-flax*, in botany, a genus of the Didynamia Angiosperma. Calyx five-parted; corol with a nectariferous prominence at its base, pointing downwards; the orifice closed and furnished with a cloven convex palate; capsule two-celled. This genus is separated into five divisions, *viz.* A. leaves angular; capsules many valved B. leaves opposite; capsules many valved. C. leaves alternate; capsules many valved. D. corols without spur; capsules perforated with three pores. E. leaves pinnatifid. There are 12 species of the first division; nearly 40 of the second division; 11 of the third; 7 of the fourth; and 2 of the last.

ANTISTROPHE, in grammar, a figure, by which two things mutually dependent on one another are reciprocally converted. As the servant of the master, and the master of the servant.

ANTISTROPHE, among lyric poets, that part of a song and dance in use among the ancients, which was performed before the altar, in returning from west to east, in opposition to strophe. See the articles STROPHE and ODE.

ANTITHESIS, in rhetoric, a contrast drawn between two things, which thereby serve as shades to set off the opposite qualities of each other.

The poets, historians, and orators, improve their subject, and greatly heighten the pleasure of the reader, by the pleasing opposition of their characters and descriptions.

The beautiful antithesis of Cicero, in his second Cartilinarian, may serve for an example; "On the one side stands modesty, on the other impudence; on the one fidelity, on the other deceit; here piety, there sacrilege; here continency, there lust, &c." And Virgil, in his admirable description of Dido's despair, the night before her death, represents all the rest of the creation enjoying profound tranquillity, to render the disquietude of that miserable queen the more affecting.

ANTOECI, in geography, an appellation given to those inhabitants of the earth who live under the same meridian, but on different sides of the equator, and at equal distances from it.

These have noon, and midnight, and all hours at the same time, but contrary seasons of the year; that is, when it is spring with the one, it is autumn with the other: when summer with the one, winter with the other. And the days of the one are equal to the nights of the other, and *vice versa*.

ANTONOMASIA, in rhetoric, a figure, by which the proper name of one thing is applied to several others; or, on the contrary, the name of several things to one. Thus we call a cruel person, a Nero: and we say the philosopher, to denote Aristotle.

ANTS, *acid of*. See FORMIC ACID.

ANVIL, an iron instrument, on which smiths hammer or forge their work, and usually mounted on a firm wooden block. A forged anvil is reckoned better than one of cast work.

ANUS, in anatomy, the extremity of the intestinum rectum, or orifice of the fundament. See ANATOMY.

AORIST, among grammarians, a tense peculiar to the Greek language, comprehending all the tenses; or rather expressing an action in an indeterminate manner, without any regard to past, present, or future.

* "Many of the curiosities found in the western country are deposited in the museum of the Philosophical Society of Philadelphia.

AORTA, in anatomy, called also arteria magna, a large artery, arising with a single trunk from the left ventricle of the heart above its valves, called semilunares, and serves to convey the mass of blood to all parts of the body.

After ascending a little upwards, its trunk is bent, in manner of an arch, and from this part it sends, in human subjects, usually three ascending branches. This is called the aorta ascendens.

The descendens is that part of the trunk, which, after the arch-like inflection, descends through the thorax and the abdomen down to the os sacrum, and is usually larger in women than in men. The aorta hath four tunics, a nervous, a glandulous, a muscular, and a membranous one. See ANATOMY.

APACTIS, in botany, a genus of the Dodecandria Monogynia class and order. No calyx; petals four, crenate, unequal; germ superior; fruit. There is but a single species, *viz.* the Japonica, a tree found, as its name imports, in Japan.

APALUS, in natural history, a genus of insects of the order Coleoptera. Gen. char. antennæ filiform; feelers equal, filiform; jaw horny, one-toothed; lip membranaceous, truncate, entire. There are two species: quadrimaculatus; rufous; head, and two spots on the shells, black; inhabits North America: bimaculatus, of northern Europe.

APARGIA, in botany, a genus of the Syngenesia Æqualis class and order. Receptacle naked; calyx imbricate; down feathery, sessile. There are 17 species.

APATITE, in mineralogy, one of the species of the phosphates, occurs in tin veins, and is found in Cornwall and Germany. Colours white, green, blue, and red, of various shades. The primitive form of its crystals is a regular six-sided prism. Specific gravity between 2.8 and 3.2. When laid on ignited coals it emits a green light, and is almost entirely soluble in nitric acid. By rubbing it shews signs of electricity. It was formerly considered as a species of schorl; afterwards, on account of its colour and crystallization, it was arranged with beryll; others described it as fluor, but Werner soon found that it was a new species. Its fallacious resemblance to other minerals induced Werner to give it this name, which is derived from απατάω, "to deceive."

APE. See SIMIA.

APETALOSE, or APETALOUS, among botanists, an appellation given to such plants as have no flower leaves.

APEX, in antiquity, the crest of a helmet, but more especially a kind of cap worn by the flamens.

APHÆRESIS, in grammar, a figure by which a letter or syllable is cut off from the beginning of a word.

APHÆRESIS, that part of surgery which teaches to take away superfluities.

APHELIUM, or APHELION, in astronomy, is that point in any planet's orbit, in which it is farthest distant from the sun; being, in the new astronomy, that end of the greater axis of the elliptical orbit of the planet, most remote from the focus wherein the sun is. The times of the aphelia of the primary planets may be known by their apparent diameters appearing least; as also by their moving slowest in a given time. They may likewise be found by calculation, the method of doing which is delivered in most astronomical writers.

Sir Isaac Newton and Dr. Gregory have proved that the aphelia of the primary planets are at rest. See Princip. prop. 14. lib. 3. And in the scholium to the above proposition they say, that the planets nearest to the sun, *viz.* Mercury, Venus, the Earth, and Mars, from the actions of Jupiter and Saturn upon them, move a small matter in consequentia with regard to the fixed stars, and that in the sesquiplicate ratio of their respective distances from the sun.

APHIS, in entomology, a genus of the Hemiptera order, which has engaged the attention of naturalists for various reasons: their generation exhibits a singular and surprising phenomenon, and their instinctive economy differs, in some respects, from that of most other animals. Linnæus defines the generic character of the aphis thus; beak inflected, sheath of five articulations, with a single bristle a antennæ setaceous, and longer than the thorax; either four erect wings or none; feet formed for walking; posterior part of the abdomen usually furnished with two little horns. Geoffroy says, the aphides have two beaks, one of which is seated in the breast, the other in the head; this last extends to and is laid upon the base of the pectoral one, and serves, as that writer imagines, to convey to the head a part of that nourishment which the insect takes, or sucks in, by means of the pectoral beak. Gmelin enumerates about 70 species, all of which, and doubtless many others, are found in different parts of Europe and America. They infest an endless variety of plants; and it is believed each species is particularly attached to one kind of vegetable only; hence each

sort has been hitherto uniformly named after the individual species or genus of plants on which it feeds; or if that could not be ascertained, that on which it had been found; for some species are rather uncommon and little known, though others are infinitely too numerous. The aphides are sufficiently known by the indiscriminate term of plant-lice; they abound with a sweet and grateful moisture, and are therefore eagerly sought after by ants, and are devoured by the larva of coccinellæ, and many other creatures, or they would become, very probably, more destructive to the whole vegetable creation than any other race of insects known. If Bonnet was not the first naturalist (as is generally acknowledged) who discovered the mysterious course of generation in the aphides, or, as he calls them, pucerons, his experiments, together with those of his countryman Trembly, tended at least to confirm, in a most satisfactory manner, the almost incredible circumstances respecting it, that an aphis or puceron, brought up in the most perfect solitude from the moment of its birth, in a few days will be found in the midst of a numerous family; and that if the experiment be again repeated on one of the individuals of this family, a second generation will multiply like its parent; and the like experiment may be many times repeated with the same effect, until at last the progeny becomes barren, unless again impregnated by the male; after which several generations may be again produced without further aid of the male, as before.

The history of aphides has also been very copiously treated upon by Dr. Richardson, in a paper printed in the 41st vol. of the Philosophical Transactions; and by the late ingenious Mr. Curtis, in the sixth volume of the Transactions of the Linnæan Society. The tenor of Dr. Richardson's remarks is briefly this: the great variety of species which occur in the insects now under consideration may make an inquiry into their particular natures seem not a little perplexing, but by reducing them under their proper genus, the difficulty is considerably diminished. We may reasonably suppose all the insects, comprehended under any distinct genus, to partake of one general nature; and by diligently examining any particular species, may thence gain some insight into the nature of all the rest. With this view, Dr. Richardson chose out of the various sorts of aphides the largest of those found on the rose-tree; not only as its size makes it more conspicuous, but there are few of so long duration. This sort appears early in the spring, and continues late in autumn, while several are limited to a much shorter term, in conformity to the different trees and plants whence they draw their nourishment. If, at the beginning of February, the weather happens to be so warm as to make the buds of the rose-tree swell and appear green, small aphides are frequently to be found on them, though not larger than the young ones in summer when first produced. It will be found, that those aphides which appear only in spring proceed from small black oval eggs, which were deposited on the last year's shoot; though when it happens that the insects make too early an appearance, the greater part suffer from the sharp weather that usually succeeds, by which means the rose-trees are some years in a manner freed from them. The same kind of animal is then at one time of the year viviparous, and at another oviparous. These aphides, which withstand the severity of the weather, seldom come to their full growth before the month of April, at which time they usually begin to breed, after twice casting off their exuvia, or outward covering. It appears that they are all females, which produce each of them a numerous progeny, and that without having intercourse with any male insect: they are viviparous, and, what is equally singular, they all come into the world backwards. When they first come from the parent, they are inveloped in a thin membrane, having in this situation the appearance of an oval egg; these egg-like appearances adhere by one extremity to the mother, while the young ones contained in them extend to the other, and by that means gradually drag the ruptured membrane over the head and body to the hind feet. During this operation, and for some time after, the fore part of the head adheres, by means of something that is glutinous, to the vent of the parent. Being thus suspended in the air, it soon frees itself from the membrane in which it was confined; and after its limbs are a little strengthened, is set down on some tender shoots, and is left to provide for itself. In the spring months, there appear on the rose-trees but two generations of aphides, including those which proceed immediately from the last year's eggs; the warmth of the summer adds so much to their fertility, that no less than five generations succeed one another in the interval. One is produced in May, which casts off its covering; while the months of June and July each supply two more,

which cast off their coverings three or four times, according to the different warmth of the season. This frequent change of their outward coat is the more extraordinary, because it is repeated more often when the insects come the soonest to their growth, which sometimes happens in ten days, when they have had plenty of warmth and nourishment. Early in the month of June, some of the third generation, which were produced about the middle of May, after casting off the last covering, discover four erect wings, much longer than their bodies; and the same is observable in all the succeeding generations which are produced during the summer months, but still without any diversity of sex: for some time before the aphides come to their full growth, it is easy to distinguish which will have wings, by a remarkable fulness of the breast, which in the others is hardly to be distinguished from the body. When the last covering is rejected, the wings which were before folded up in a very narrow compass, are gradually extended in a surprising manner, till their dimensions are at last very considerable. The increase of these insects in the summer-time is so very great, that by wounding and exhausting the tender shoots, they would frequently suppress all vegetation, had they not many enemies to restrain them. Notwithstanding these insects have a numerous tribe of enemies, they are not without their friends, if those may be considered as such, who are officious in their attendance for the good things they expect to reap thereby. The ant and bee are of this kind, collecting the honey in which the aphides abound, but with this difference, that the ants are constant visitors, the bee only when flowers are scarce; the ants will suck in the honey, while the aphides are in the act of discharging it; the bees only collect it from the leaves on which it has fallen. The aphides are often carried home by the ant, carefully attended, and regularly supplied with food. See Formica. In the autumn three more generations of aphides are produced, two of which generally make their appearance in the month of August, and the third befort the middle of September. The two first differ in no respect from those which are found in summer, but the third differs greatly from all the rest. Though all the aphides which have hitherto appeared were female, in this generation several male insects are found, but not by any means so numerous as the females. The females have, at first, the same appearance as those of the former generations, but in a few days their colour changes from a green to a yellow, which is gradually converted into an orange before they come to their full growth; they differ, also, in another respect, from those which occur in summer, for all these yellow females are without wings. The male insects are, however, still more remarkable, their outward appearance readily distinguishing them from this and all other generations. When first produced they are not of a green colour like the rest, but of a reddish brown, and have afterwards a dark line along the back: they come to their full growth in about three weeks, and then cast off their last covering, the whole insect being, after this, of a bright yellow colour, the wings only excepted; but after this change they become of a deeper yellow, and in a very few hours of a dark brown, if we except the body, which is something lighter coloured and has a reddish cast. The males no sooner come to maturity than they copulate with the females, who, in a day or two after their intercourse with the males, lay their eggs, generally near the buds. Where there are a number crowded together, they, of course, interfere with each other, in which case they will frequently deposit their eggs on other parts of the branches.— It is highly probable that the aphides derive considerable advantages by living in society; the reiterated punctures of a great number of them may attract a larger quantity of nutricious juices to that part of the tree or plant where they have taken up their abode. The observations of Mr. Curtis on the aphides are chiefly intended to shew that they are the principal cause of blights in plants, and the sole cause of the honey-dew. He therefore calls them the aphis, or blighter; and after observing, that, in point of numbers, the individuals of the several species composing it surpass those of any other genus in the country, speaks thus, in general terms, of the whole tribe. These insects live entirely on vegetables. The loftiest tree is no less liable to their attacks than the most humble plant. They prefer the young shoots on account of their tenderness, and on this principle often insinuate themselves into the very heart of the plant, and do irreparable mischief before they are discovered. But, for the most part, they beset the foliage, and are mostly found on the underside of the leaf, which they prefer, not only on account of its being the most tender, but as it affords them protection from the weather, and various injuries to which they would otherwise be exposed. Sometimes the root is the

object of their choice, which, from the nature of these insects, one would not, *a priori*, expect; yet I have seen the roots of lettuces thickly beset with them, and the whole crop rendered sickly and of little value; but such instances are rare. They seldom attach themselves to the bark of trees, like the aphis salicis, which, being one of our largest species, and hence possessing superior strength, is enabled to penetrate a substance harder than the leaves themselves. In the quality of the excrement voided by these insects, there is something wonderfully extraordinary. Were a person accidentally to take up a book, in which it was gravely asserted, that in some countries there were certain animals which voided liquid sugar, he would lay it down, regarding it as a fabulous tale, calculated to impose on the credulity of the ignorant; and yet such is literally the truth. Mr. Curtis collected some on a piece of writing-paper, from a brood of the aphis salicis, and found it to be sweet as sugar; and observes, that, were it not for the wasps, ants, flies, and other insects, that devour it as quickly as it is produced, it might, no doubt, be collected in considerable quantities, and by the processes used with other saccharine juices, might be converted into the choicest sugar or sugar-candy. The sweetness of this excrementitious substance, the glossy appearance it gave the leaves it fell upon, and the swarm of insects this matter attracts, led him to imagine that the honey-dew of plants was no other than this secretion, which further observation has since fully confirmed; and not, as its name implies, a sweet substance falling from the atmosphere. On this opinion it is further remarked, that it neither falls from the atmosphere, nor issues from the plant itself, as is easily demonstrated. If it fell from the atmosphere, it would cover every thing it fell upon indiscriminately, whereas we never find it but on certain living plants and trees. We find it also on plants in stoves and green-houses, covered with glass. If it exuded from the plant, it would appear on all the leaves generally and uniformly; whereas its appearance is extremely irregular, not alike on any two leaves of the same tree or plant, some having none of it, and others being covered with it but partially. It is probable that there never exists any honey-dew but where there are aphides; though such often pass unnoticed, being hidden on the underside of the leaf: and wherever honey-dew is observable upon a leaf, aphides will be found on the under side of the leaf or leaves immediately above it, and under no other circumstance whatever. If by accident anything should intervene between the aphides and the leaf next beneath them, there well be no honey-dew on that leaf: and thus he conceives it is incontrovertibly proved, that aphides are the true and only source of honey-dew. Of the British species of aphides, one of the largest and most remarkable is the aphis salicis, which is found on the different kinds of willows. When bruised, these insects stain the fingers with red. Towards the end of September multitudes of the full-grown insects of this species, both with and without wings, desert the willows on which they feed, and ramble over every neighbouring object in such numbers, that we can handle nothing in their vicinity without crushing some of them, while those in a younger or less advanced state still remain in large masses upon the trees. Aphis rosæ is very frequent, during the summer months, on the young shoots and buds of roses: it is of a bright green colour: the males are furnished with large transparent wings. A. vitis is most destructive to vines; as A. ulmi is to the elm-tree. Plate 1. Entomology, fig. 3.

It is found, that where the saccharine substance has dropped from aphides for a length of time, as from the aphis salicis in particular, it gives to the surface of the bark, foliage, &c. that sooty kind of appearance, which arises from the explosion of gunpowder: it looks like, and is sometimes taken for, a kind of black mildew. In most seasons the natural enemies of the aphides are sufficient to keep them in check, and to prevent them from doing essential injury to plants in the open air: but there are times, once perhaps in four, five, or six years, in which they are multiplied to such an excess, that the usual means of diminution fail in preventing them from doing irreparable injury to certain crops.

To prevent the calamities which would infallibly result from an accumulated multiplication of the more prolific animals, it has been ordained by the Author of nature, that such should be diminished by serving as food for others. On this principle, most animals of this kind have one or more natural enemies. The helpless aphis, which is the scourge of the vegetable kingdom, has to contend with many: of these, the principal are, the coccinella, the ichneumon aphidum, and the musca aphidevora. The greatest destroyer of the aphides is the coccinella, or common lady-bird. During the winter this insect secures itself under the bark of

trees and elsewhere. When the spring expands the foliage of plants, the female deposits its eggs on them in great numbers, from whence, in a short time, proceeds the larva, a small grub, of a dark lead-colour spotted with orange. These may be observed in the summer season running pretty briskly over all kinds of plants, and, if narrowly watched, they will be found to devour the aphides wherever they find them. The same may be observed of the lady-bird, in its perfect state. Another most formidable enemy to the aphis is a very minute, black, and slender ichneumon fly, which eats its way out of the aphis, leaving the dry inflated skin of the insect adhering to the leaf like a small pearl: such may always be found where aphides are in plenty. Different species of aphides are infested with different ichneumons. There is scarcely a division of nature, in which the musca or fly is not found: of these, one division, the aphidivora, feeds entirely on aphides. Of the different species of aphidivorous flies, which are numerous, having mostly bodies variegated with transverse stripes, their females may be seen hovering over plants infested with aphides, among which they deposit their eggs on the surface of the leaf. The larva, or maggot, produced from such eggs, feeds, as soon as hatched, on the younger kinds of aphis, and as it increases in size, attacks and devours those which are larger. The larva of the hemerobius feeds also on the aphides, and deposits its eggs on the leaves of such plants as are beset with them. The earwig is likewise an enemy to them, especially such as reside in the curled leaves of fruit-trees, and the purses formed by certain aphides on the poplars and other trees. To these may be added the smaller soft-billed birds that feed on insects.

APHORISM, a maxim or principle of a science; or a sentence which comprehends a great deal in a few words. The term is seldom used but in medicine and law. We say, the aphorisms of Hippocrates, the aphorisms of the civil law, political aphorisms, &c.

APHRODITA, in natural history, a genus of worms, of the order Molusca. Body creeping, oblong, covered with scales, and furnished with numerous bristly fasciculate feet on each side; mouth terminal, cylindrical, retractile; feelers two, setaceous, annulate; and four eyes. There are nine species. A. aculeata has an oval body, brown, beneath flesh colour, with long silky changeable hair on each side the body: it inhabits the European seas, is found in the belly of the cod-fish, and feeds on testaceous animals; is from four to seven inches long.

APHYLLANTHES, the *blue Montpelier pink*, in botany, a genus of the Hexandria Monogynia class of plants, the calyx of which is composed of a number of imbricated, lanceolated spathæ; the corolla consists of six petals, of an obversely oval figure, terminating at the base in very narrow ungues, and patent at the limb, forming a kind of tube below it: the fruit is a turbinated capsule of a triangular figure, and contains three cells; the seeds are oval. There is but a single species.

APHYTEIA, in botany, a genus of the Monadelphia Triandria. Calyx large, funnel-form, three-cleft; three petals inserted into and shorter than the calyx; germ inferior; berry one-celled, many-seeded; seeds imbedded.

APIAN, (PETER), in biography, an eminent astronomer and mathematician, called in German *Bienewitz*, was born at Loisnich, in Misnia, and became professor of mathematics at Ingolstadt, in 1524. He wrote several treatises on astronomy and the mathematics, and enriched these sciences with many instruments and observations. His first work was a "Treatise on Cosmography, or Geographical Instructor;" this was published in 1530, and in three years after he constructed at Nuremberg a curious instrument, which shewed the hour of the day, by means of the sun's rays, in all parts of the earth. In the year 1540, he published his principal work, entitled "Astronomicon Cæsaræum," containing many interesting observations, with the descriptions and divisions of instruments, calculations of eclipses, and the construction of them in plano. In a second part of the work is a description of the construction and use of an astronomical quadrant, to which is annexed observations on five different comets: in these he shews that the tails of comets are always projected in a direction opposite to the sun. Our limits do not allow us to enumerate all the treatises of Apian: they were as respectable as numerous, and the author was treated with the kindest attention by the emperor Charles V., who published several of his works at his own expense, conferred upon him the honour of nobility, and presented him with 3000 crowns. Apian died at Ingolstadt in 1552, leaving behind him a high reputation for learning, and a son Philip, who was also an eminent astronomer, and taught the sciences both at Tubingen and Ingolstadt. Philip died in 1589, and

left a treatise on "Solar-dials." He gave an account of the new star that appeared in Cassiopeia in 1572, which is preserved.

APIARY, a garden or other convenient place where bees are kept. A southern aspect is reckoned the most proper, and the bee-hives should be exposed as little as possible to the wind, and should enjoy as much of the influence of the sun as possible, as wind retards the bees in their work, while the beams of the sun invite them to it. In the vicinity of the apiary there should be plenty of flowers, wild thyme, and the like. The hives should be free from the droppings of trees, the annoyance of dunghills, long grass and weeds; as from these insects are bred, which are not only destructive to bees, but greatly retard them in the preparation of honey. See Apis.

APIS, in natural history, a genus of insects of the order of Hymenoptera. Gen. char. mouth furnished with jaws, and an inflected proboscis, with two bivalve sheaths: feelers 4, unequal, filiform: antennæ short, filiform, those of the female subclavate; wings flat or without plaits; sting in the female and neutral insects concealed.

This genus is distributed by Linnæus into two assortments, *viz.* those in which the body of the animal is but slightly covered with fine hair or down, and those in which it is remarkably villose or hairy: the insects of the latter division are commonly distinguished by the title of humble-bees. In the first division, the principal or most important species is the apis mellifica, or common honey-bee, so long and justly celebrated for its wonderful polity, the neatness and precision with which it constructs its cells, and the diligence with which it provides, during the warmth of summer, a supply of food, for the support of the hive during the rigours of the succeeding winter. The general history of this interesting insect has been amply detailed by various authors, as Swammerdam, Reaumur, &c. &c. Among the most elaborate accounts of later times may be mentioned that of Mr. John Hunter, which made its appearance in the Philosophical Transactions for the year 1792, of which the following is an abstract. There are three periods at which the history of the bee may commence: first, in the spring, when the queen begins to lay her eggs; in the summer, at the commencement of a new colony; or in the autumn, when they go into winter quarters. We shall begin the particular history of the bee with the new colony, when nothing is formed. When a hive sends off a colony, it is commonly in the month of June; but that will vary according to the season, for in a mild spring bees sometimes swarm in the middle of May, and very often at the latter end of it. Before they come off, they commonly hang about the mouth of the hole or door of the hive, for some days, as if they had not sufficient room within for such hot weather, which we believe is very much the case; for if cold or wet weather come on, they stow themselves very well, and wait for fine weather. But swarming appears to be rather an operation arising from necessity, for they would seem not naturally to swarm, because if they have an empty space to fill they do not swarm; therefore by increasing the size of the hive the swarming is prevented. This period is much longer in some than in others. For some evenings before they come off is often heard a singular noise, a kind of ring, or sound of a small trumpet; by comparing it with the notes of a piano forte, it seemed to be the same sound with the lower A of the treble. The swarm commonly consists of three classes; a female, or females, males, and those commonly called mules, which are supposed to be of no sex, and are the labourers; the whole, about two quarts in bulk, making about six or seven thousand. It is a question that cannot easily be determined, whether this old stock sends off entirely young of the same season, and whether the whole of their young ones, or only part. As the males are entirely bred in the same season, part go off; but part must stay, and most probably it is so with the others. They commonly come off in the heat of the day, often immediately after a shower. When one goes off, they all immediately follow, and fly about seemingly in great confusion, although there is one principle actuating the whole. They soon appear to be directed to some fixed place; such as the branch of a tree or bush, the cavities of old trees, holes of houses leading into some hollow place; and whenever the stand is made, they immediately repair to it till they are all collected. But it would seem, in some cases, that they had not fixed upon any resting place before they come off, or, if they had, that they were either disturbed, if it was near, or that it was at a great distance; for, after hovering some time, as if undetermined, they fly away, mount up into the air, and go off with great velocity. When they have fixed upon their future habitation, they immediately begin

to make their combs, for they have the materials within themselves. "I have reason," says Mr. Hunter, "to believe that they fill their crops with honey when they come away, probably from the stock in the hive. I killed several of those that came away, and found their crops full, while those that remained in the hive had their crops not near so full: some of them came away with farina on their legs, which I conceive to be rather accidental. I may just observe here, that a hive commonly sends off two, sometimes three, swarms in a summer, but that the second is commonly less than the first, and the third less than the second; and this last has seldom time to provide for the winter.

"The materials of their dwelling or comb, which is the wax, is the next consideration, with the mode of forming, preparing, or disposing of it. In giving a totally new account of the wax, I shall first shew it can hardly be what it has been supposed to be. First, I shall observe that the materials, as they are found composing the comb, are not to be found in the same state (as a composition) in any vegetable, where they have been supposed to be got. The substance brought in on the legs, which is the farina of the flowers of plants, is, in common, I believe, imagined to be the materials of which the wax is made, for it is called by most the wax: but it is the farina, for it is always of the same colour as the farina of the flower where they are gathering; and indeed, we see them gathering it, and we also see them covered almost all over with it like a dust; nevertheless, it has been supposed to be the wax, or that the wax was extracted from it. Reaumur is of this opinion. I made several experiments, to see if there was such a quantity of oil in it as would account for the quantity of wax to be formed, and to learn if it was composed of oil. I held it near the candle, it burnt, but it did not smell like wax, and had the same smell, when burning, as farina when it was burnt. I observed that this substance was of different colours on different bees, but always of the same colour on both legs of the same bee; whereas a new made comb was all of one colour. I observed that it was gathered with more avidity for old hives, where the comb is complete, than for those hives where it only begun, which we could hardly conceive, if it was the materials of wax: also we may observe, that, at the very beginning of a hive, the bees seldom bring in any substance on their legs for two or three days, and after that the farina gatherers begin to increase; for now some cells are formed to hold it as a store, and some eggs are laid, which, when hatched, will require this substance as food, and which will be ready when the weather is wet.

"The wax is formed by the bees themselves; it may be called an external secretion of oil, and I have found that it is formed between each scale of the under side of the belly. When I first observed this substance, in my examination of the working bee, I was at a loss to say what it was: I asked myself if it was new scales forming, and whether they cast the old, as the lobster, &c. does? but it was to be found only between the scales on the lower side of the belly. On examining the bees through glass hives, while they were climbing up the glass, I could see that most of them had this substance, for it looked as if the lower or posterior edge of the scale was double, or that there were double scales: but I perceived it was loose, not attached. Finding that the substance brought in on their legs was farina, intended, as appeared from every circumstance, to be the food of the maggot, and not to make wax, and not having yet perceived any thing that could give me the least idea of wax, I conceived these scales might be it, at least I thought it necessary to investigate them. I therefore took several on the point of a needle, and held them to a candle, where they melted, and immediately formed themselves into round globules; upon which I no longer doubted but this was the wax, which opinion was confirmed to me by not finding those scales but in the building season.

"The cells, or rather the congeries of cells, which compose the comb, may be said to form perpendicular plates, or partitions, which extend from top to bottom of the cavity in which they build them, and from side to side. They always begin at the top or roof of the vault in which they build, and work downwards: but if the upper part of this vault to which their combs are fixed is removed, and a dome is put over, they begin at the upper edge of the old comb, and work up into the new cavity at the top. They generally may be guided, as to the direction of their new plates of comb, by forming ridges at top, to which they begin to attach their comb. In a long hive, if these ridges are longitudinal, their plates of comb will be longitudinal: if placed transverse, so will be the plates; and if oblique, the plates of comb will be

oblique. Each plate consists of a double set of cells, whose bottoms form the partition between each set. The plates themselves are not very regularly arranged, not forming a regular plane where they might have done so; but are often adapted to the situation or shape of the cavity in which they are built. The bees do not endeavour to shape their cavity to their work, as the wasps do, nor are the cells of equal depths, also fitting them to their situation; but as the breeding cells must all be of a given depth, they reserve a sufficient number for breeding in, and they put the honey into the others, as also into the shallow ones. The attachment of the comb round the cavity is not continued, but interrupted so as to form passages; there are also passages in the middle of the plates, especially if there be a cross stick to support the comb; these allow of bees to go across from plate to plate. The substance which they use for attaching their combs to surrounding parts is not the same as the common wax; it is softer and tougher, a good deal like the substance with which they cover in their crysalis, or the humble-bee surrounds her eggs. It is probably a mixture of wax with farina. The cells are placed nearly horizontally, but not exactly so; the mouth raised a little, which probably may be to retain the honey the better; however, this rule is not strictly observed, for often they are horizontal, and towards the lower edge of a plane of comb they are often declining. The first combs that a hive forms are the smallest, and much neater than the last or lowermost. Their sides or partitions, between cell and cell, are much thinner, and the hexagon is much more perfect. The wax is purer, being probably little else but wax, and it is more brittle. The lower combs are considerably larger, and contain much more wax, or perhaps, more properly, more materials; and the cells are at such distances as to allow them to be of a round figure: the wax is softer, and there is something mixed with it. I have observed that the cells are not all of equal size, some being a degree larger than the others; and that the small are the first formed, and of course at the upper part, where the bees begin, and the larger are nearer the lower part of the comb, or last made: however, in hives of particular construction, where the bees may begin to work at one end, and can work both down and towards the other end, we often find the larger cells both on the lower part of the combs, and also at the opposite end. These are formed for the males to be bred in; and in the hornets and wasps combs there are larger cells, for the queens to be bred in: these are also formed in the lower tier, and the last formed.

"The first comb made in a hive is all of one colour, *viz.* almost white; but is not so white towards the end of the season, having then more of a yellow cast.

"There is a cell which is called the royal cell, often three or four of them, sometimes more; I have seen eleven, and even thirteen, in the same hive; commonly they are placed on the edge of one or more of the combs, but often on the side of a comb; however, not in the centre along with the other cells, like a large one placed among the others, but often against the mouths of the cells, and projecting out beyond the common surface of the comb; but most of them are formed from the edge of the comb, which terminates in one of these cells. The royal cell is much wider than the others, but seldom so deep: its mouth is round, and appears to be the largest half of an oval in depth, and is declining downwards, instead of being horizontal or lateral. The materials of which it is composed are softer than common wax, rather like the last mentioned, or those of which the lower edge of the plate of comb is made, or with which the bees cover the crysalis: they have very little wax in their composition, not one third, the rest I conceive to be farina.

"The comb seems at first to be formed for propagation, and the reception of honey to be only a secondary use; for if the bees lose their queen, they make no combs; and the wasp, hornet, &c. make combs, although they collect no honey; and the humble-bee collects the honey, and deposits it in cells she never made.

"I shall not consider the bee as an excellent mathematician, capable of making exact forms, and having reasoned upon the best shape of the cell for capacity, so that the greatest number might be put into the smallest space (for the hornet and the wasp are much more correct, although not seemingly under the same necessity, as they collect nothing to occupy their cells); because, although the bee is pretty perfect in these respects, yet it is very incorrect in others, in the formation of the comb; nor shall I consider these animals as forming combs of certain shape and size, from mere mechanical necessity, as from working round themselves; for such a mould would not form cells of dif-

ferent sizes, much less could wasps be guided by the same principle, as their cells are of very different sizes, and the first by much too small for the queen wasp to have worked round herself: but I shall consider the whole as an instinctive principle, in which the animal has no power of variation or choice, but such as arises from what may be called external necessity. The cell has in common six sides, but this is most correct in those first formed; and the bottom is commonly composed of those sides or planes, two of the sides making one; and they generally fall in between the bottoms of three cells of the opposite side; but this is not regular, it is only to be found where there is no external interruption.

"As soon as a few combs are formed, the female bee begins laying of eggs. As far as I have been able to observe, the queen is the only bee that propagates, although it is asserted that the labourers do. Her first eggs in the season are those which produce labourers; then the males, and probably the queen; this is the progress in the wasp, hornet, humble-bee, &c. However, it is asserted by Riem, that when a hive is deprived of a queen, labourers lay eggs; also, that at this time some honey and farina are brought in, as store for a wet day. The eggs are laid at the bottom of the cell, and we find them there before the cells are half completed, so that propagation begins early, and goes on along with the formation of the other cells. The egg is attached at one end to the bottom of the cell, sometimes standing perpendicularly, often obliquely; it has a glutinous, or slimy covering, which makes it stick to any thing it touches. It would appear that there was a period or periods for laying eggs; for I have observed in a new swarm, that the great business of laying eggs did not last above a fortnight; although the hive was not half filled with comb, it began to slacken. In those new formed combs, as also in many not half finished, we find the substance called bee-bread, and some of it is covered over with wax, which will be considered further. By the time they have worked above half way down the hive with the comb, they are beginning to form for the larger cells, and by this time the first broods were hatched, which were small, or labourers; and now they begin to breed males, and probably a queen, for a new swarm: because the males are now bred to impregnate the young queen for the present summer, as also for the next year. This progress in breeding is the same with that of the wasp, hornet, and humble-bee. Although this account is commonly allowed, yet writers on this subject have supposed another mode of producing a queen, when the hive is in possession of maggots, and deprived of their queen.

"What may be called the complete process of the egg, namely, from the time of laying to the birth of the bee, (that is, the time of hatching) the life of the maggot, and the life of the crysalis, is, I believe, shorter than in most insects. It is not easy to fix the time when the eggs hatch: I have been led to imagine it was in five days. When they hatch, we find the young maggot lying coiled up in the bottom of the cell, in some degree surrounded with a transparent fluid. In many of the cells, where the eggs have just hatched, we find the skin standing in its place, either not yet removed, or not pressed down by the maggot. There is now an additional employment for the labourers, namely, the feeding and nursing the young maggots. We may suppose the queen has nothing to do with this, as there are at all times labourers enough in the hive for such purposes, especially, too, as she never does bring the materials, as every other of the tribe is obliged to do at first; therefore she seems to be a queen by hereditary, or rather by natural, right, while the humble-bee, wasp, hornet, &c. seem rather to work themselves into royalty, or mistresses of the community. The bees are readily detected feeding the young maggot; and, indeed, a young maggot might easily be brought up by any person who would be attentive to it. They open their two lateral pincers to receive the food and swallow it. As they grow, they cast their coats or cuticles; but how often they throw their coats, while in the maggot state, I do not know. The maggots grow larger and larger till they nearly fill the cell; and by this time they require no more food, and are ready to be inclosed for the crysalis state; when ready for the crysalis state, the bees cover over the mouth of the cell with a substance of a light brown colour, much in the same manner that they cover the honey, excepting that, in the present instance, the covering is convex externally, and appears not to be entirely wax, but a mixture of wax and farina. The maggot is now perfectly inclosed, and it begins to line the cell and covering of the mouth above-mentioned with a silk it spins out, similar to the silk-worm, and which makes a kind of pod for the chrysalis.

Having completed this lining, they cast off, or rather shove off, from the head backwards, the last maggot coat, which is deposited at the bottom of the cell, and then they become chrysalises.

"In this state they are forming themselves for a new life: they are either entirely new built, or wonderfully changed, for there is not the smallest vestige of the old form remaining; yet it must be the same materials, for now nothing is taken in. How far this change is only the old parts new modelled, or gradually altering their form, is not easily determined. To bring about the change, many parts must be removed, out of which the new ones are probably formed. As bees are not different in this state from the common flying insects in general, I shall not pursue the subject of their changes further, although it makes a very material part in the natural history of insects.

"When the crysalis is formed into the complete bee, it then destroys the covering of its cell and comes forth. They are of a greyish colour, but soon turn brown.

"When the swarm of which I have hitherto been giving the history has come off early, and is a large one, more especially if it was put into too small a hive, it often breeds too many for the hive to keep through the winter; and in such case a new swarm is thrown off, which, however, is commonly not a large one, and generally has too little time to complete its comb, and store it with honey sufficient to preserve them through the winter. This is similar to the second or third swarm of the old hives.

"I have already observed, that the new colony immediately sets about the increase of their numbers, and every thing relating to it. They had their apartments to build, both for the purpose of breeding, and as a store-house for provisions for the winter. When the season for laying eggs is over, then is the season for collecting honey; therefore, when the last chrysalis for the season comes forth, its cell is immediately filled with honey; and as soon as the cell is full, it is covered over with pure wax, as it is to be considered as store for the winter. This covering answers two very essential purposes: one is to keep it from spilling, or daubing the bees; the other to prevent its evaporation, by which means it is kept fluid in such a warmth. They are also employed in laying up a store of bee-bread for the young maggots in the spring, for they begin to bring forth much earlier than probably any other insect, because they retain a summer heat, and store up food for the young.

"In the month of August we may suppose the queen, or queens, are impregnated by the males; and as the males do not provide for themselves, they become burdensome to the workers, and are therefore teased to death much sooner than they otherwise would die; and when the bees set about this business of providing their winter store, every operation is over, except the collecting of honey and bee-bread. At this time it would seem as if the males were conscious of their danger, for they do not rest in the mouth of the hive, in either going out or coming in, but hurry either in or out: however, they are commonly attacked by one, two, or three at a time: they seem to make no resistance, only getting away as fast as possible. The labourers do not sting them, only pinch them, and pull them about as if to wear them out; but I suspect it may be called as much a natural as a violent death.

"When the young are wholly come forth, and either the cells entirely filled, or no more honey to be collected, then is the time or season for remaining in their hives for the winter.

"Although I have now completed a hive, and no operations are going on in the winter months, yet the history of this hive is imperfect till it sends forth a new swarm.

"As the common bee is very susceptible of cold, we find, as soon as the cold weather sets in, they become very quiet or still, and remain so throughout the winter, living on the produce of the summer and autumn; and, indeed, a cold day in the summer is sufficient to keep them at home, more so than a shower in a warm day: and if the hive is thin and much exposed, they will hardly move in it, but get as close together as the comb will let them, into a cluster. In this manner they appear to live through the winter: however, in a fine day they become very lively and active, going abroad, and appearing to enjoy it, at which time they get rid of their excrement: for I fancy they seldom throw out their excrement when in the hive.

"Their life at this season of the year is more uniform, and may be termed simple existence, till the warm weather arrives again. As they now subsist on their summer's industry, they would seem to feed in proportion to the coldness of the season; for, from experiment, I found the hive grow lighter in a cold week than it did in

a warmer, which led to further experiments.

"Although an indolent state is very much the condition of bees through the winter, yet progress is making in the queen towards a summer's increase. The eggs in the oviducts are beginning to swell, and, I believe, in the month of March, she is ready to lay them, for the young bees are to swarm in June; which constitutes the queen bee to be the earliest breeder of any insect we know. In consequence of this the labourers become sooner employed than any other of this tribe of insects. This, both queen and labourers are enabled to accomplish, from living in society through the winter; and it becomes necessary in them, as they have their colony to form early in the summer, which is to provide for itself for the winter following. All this requires the process to be carried forward earlier than by any other insect, for these are only to have young, which are to take care of themselves through the summer, not being under the necessity of providing for the winter.

"The queen bee, as she is termed, has excited more curiosity than all the others, although much more belong to the labourers. From the number of these, and from their exposing themselves, they have their history much better made out: but as there is only one queen, and she scarcely ever seen, it being only the effects of her labour we can come at, an opportunity has been given to the ingenuity of conjecture, and more has been said than can well be proved. The queen, the mother of all, in whatever way produced, is a true female, and different from both the labourers and the male. She is not so large in the trunk as the male, and appears to be rather larger in every part than the labourers. The scales on the under surface of the belly of the labourers are not uniformly of the same colour over the whole scale, that part being lighter which is overlapped by the terminating scale above, and the uncovered part being darker. This light part does not terminate in a straight line, but in two curves, making a peak; all which gives the belly a lighter colour in the labouring bees, more especially when it is pulled out or elongated. We distinguish a queen from a working bee simply by size, and in some degree by colour, but this last is not so easily ascertained, because the difference in the colour is not so remarkable in the back, and the only view we can commonly get of her is on this part; but when a hive is killed, the best way is to collect all the bees, and spread them on white paper, or put them into water, in a broad, flat-bottomed, shallow, white dish, in which they swim, and by looking at them singly, she may be discovered. As the queen breeds the first year she is produced, and the oviducts never entirely subside, an old queen is probably thicker than a new-bred one, unless indeed the oviducts and the eggs form in the chrysalis state, as in the silk-worm, which I should suppose they did. The queen is perhaps at the smallest size just as she has done breeding; for as she is to lay eggs by the month of March, she must begin early to fill again; but I believe her oviducts are never emptied, having at all times eggs in them, although but small. She has fat in her belly, similar to the other bees.

"It is most probable that the queen which goes off with the swarm is a young one, for the males go off with the swarm to impregnate her, as she must be impregnated the same year, because she breeds the same year.

"The queen has a sting similar to the working-bee.

"I believe a hive, or swarm, has but one queen, at least I have never found more than one in a swarm, or in an old hive in the winter; and probably this is what constitutes a hive; for when there are two queens, it is likely that a division may begin to take place. Supernumerary queens are mentioned by Riem, who asserts he has seen them killed by the labourers as well as the males.

"The male bee is considerably larger than the labourers: he is even larger than the queen, although not so long when she is in her full state with eggs: he is considerably thicker than either, but not longer in the same proportion: he does not terminate at the anus in so sharp a point; and the opening between the two last scales of the back and belly is larger, and more under the belly, than in the female. His proboscis is much shorter than that of the labouring bee, which makes me suspect he does not collect his own honey, but takes that which is brought home by the others; especially as we never find the males abroad on flowers, &c. only flying about the hives in hot weather, as if taking an airing; and when we find that the male of the humble-bee, which collects its own food, has as long a proboscis, or tongue, as the female, I think it is from all these facts reasonable to suppose the male of the common bee feeds at home. He has no sting.

"The class of labouring bees, for we cannot call it either sex or species, is the

largest in number of the whole community: there are thousands of them to one queen, and probably some hundreds to each male. It is to be supposed they are the only bees which construct the whole hive, and that the queen has no other business but to lay the eggs: they are the only bees that bring in materials; the only ones we observe busy abroad; and indeed the idea of any other is ridiculous, when we consider the disproportion in numbers, as well as the employment of the others, while the working bee has nothing to take off its attention to the business of the family. They are smaller than either the queen or the males: not all of equal size, although the difference is not very great.

"The queen and the working bees are so much alike, that the latter would seem to be females on a different scale: however, this difference is not so observable in the beginning of winter as in the spring, when the queen is full of eggs. They are all females in construction; indeed, one might suppose that they were only young queens, and that they became queens after a certain age; but this is not the case. They all have stings, which is another thing that makes them similar to the queen. From their being furnished with an instrument of defence and offence, they are endowed with such powers of mind as to use it, their minds being extremely irritable; so much so, that they make an attack when not meddled with, simply upon suspicion, and when they do attack they always sting; and yet, from the circumstance of their not being able to disengage the sting, one should suppose they would be more cautious in striking with it. When they attack one another, they seldom use it, only their pincers: yet I saw two bees engaged, and one stung the other in the mouth, or thereabouts, and the sting was drawn from the body to which it belonged, and the one who was stung ran very quickly about with it; but I could not catch that bee, to observe how the sting was situated.

"As they are the collectors of honey, much more than what is for their own use either immediately or in future, their tongue is proportionably fitted for that purpose: it is considerably larger than that of either the queen or the male, which fits them to take up the honey from the hollow parts of flowers of considerable depth. The mechanism is very curious, and will be explained further on.

"Bees certainly have the five senses: sight none can doubt: feeling they also have; and there is every reason for supposing they have likewise taste, smell, and hearing. Taste we cannot doubt; but of smell we may not have such proofs; yet, from observation, I think they give strong signs of smell. When bees are hungry, as a young swarm in wet weather, and are in a glass hive, so that they can be examined, if we put some honey into the bottom, it will immediately breed a commotion; they all seem to be upon the scent: even if they are weak, and hardly able to crawl, they will throw out their proboscis as far as possible to get to it, although the light is very faint. This last appears to arise more from smell than seeing. If some bees are let loose in a bee-hive, and do not know from which honse they came, they will take their stand upon the outside of some hive, or hives, especially when the evening is coming on: whether this arises from the smell of the hives, or sound, I can hardly judge.

"Bees may be said to have a voice. They are certainly capable of forming several sounds. They give a sound, when flying, which they can vary according to circumstances. One accustomed to bees can immediately tell when a bee makes an attack, by the sound. This is probably made by the wings. They may be seen standing at the door of their hive, with the belly rather raised, and moving their wings, making a noise. But they produce a noise independent of their wings; for if a bee is smeared all over with honey, so as to make the wings stick together, it will be found to make a noise which is shrill and peevish. I have observed that they, or some of them, make a noise the evenings before they swarm, which is a kind of ring, or sound of a small trumpet: by comparing it with the notes of the piano-forte, it seemed to be the same with the lower A of the treble.

"I have observed, that it is only the queen and the labourers that have stings; and this provision of a sting is perhaps as curious a circumstance as any attending the bee, and probably is one of the characters of the bee tribe.

"The apparatus itself is of a very curious construction, fitted for inflicting a wound, and at the same time conveying a poison into that wound. The apparatus consists of two piercers, conducted in a groove or director, which appears to be itself the sting. All these parts are moved by muscles, which we may suppose are very strong in in them, much stronger than in other animals; and these muscles give motion in almost all directions, but more particularly outwards. It is wonderful how deep they will pierce solid bodies with the sting. I have examined the length they have pierc-

ed the palm of the hand, which is covered with a thick cuticle: it has often been about the one-twelfth of an inch. To perform this by mere force, two things are necessary, power of muscles, and strength of the sting, neither of which they seem to possess in sufficient degree. I own I do not understand this operation. I am apt to conceive there is something in it distinct from simple force applied to one end of a body: for if this was simply the case, the sting of the bee could not be made to pierce by any power applied to its base, as the least pressure bends it in any direction: it is possible the serrated edges may assist, by cutting their way in like a saw.

"The apparatus for the poison consists of two small ducts, which are the glands that secrete the poison: these two lie in the abdomen, among the air-cells, &c.; they both unite into one, which soon enters into or forms an oblong bag, like a bladder of urine; at the opposite end of which passes out a duct, which runs towards the angle where the two stings meet, and entering between the two stings, is continued between them in a groove, which forms a canal by the union of the two stings to this point. There is another duct on the right of that described above, which is not so circumscribed, and contains a thicker matter, which, as far as I have been able to judge, enters along with the other; but it is the first that contains the poison, which is a thin, clear fluid. From the stings having serrated edges, it is seldom the bees can disengage them; and they immediately upon stinging endeavour to make their escape, but are generally prevented, as it were caught in their own trap; and the force they use commonly drags out the whole of the apparatus for stinging, and also part of the bowels; so that the bee most frequently falls a sacrifice immediately upon having effected its purpose. Upon a superficial view, one conceives that the first intention of the bee having a sting is evident; one sees it has property to defend, and that therefore it is fitted for defence; but why it should naturally fall a sacrifice in its own defence does not so readily appear; besides, all bees have stings, although all bees have not property to defend, and therefore are not under the same necessity of being so provided. Probably its having a sting to use was sufficient for nature to defend the bee, without using it liberally; and the loss of a bee or two, when they did sting, was of no consequence, for it is seldom that more die."

Some naturalists suppose that the queen is formed from the larvæ of the working bee; by a particular mode of treatment, or peculiarity or quantity of food, the bulk is augmented, and the generative organs developed.

We now proceed to notice some of the species. The apis centuncularis, or carpenter-bee, is remarkable for its faculty of forming long, tubular, and slightly flexuose cavities in wood, even of the most solid kind, as oak, &c. Sometimes it performs this operation in living trees, and sometimes in dry wood, posts, &c. When the tube is properly finished, the animal proceeds to line each of the above-mentioned spaces with rose-leaves rolled over each other, the bottom of each being formed by several circular pieces of these leaves, placed immediately over each other to a sufficient thickness. The animal then deposits an egg at the bottom, and having left in the cell a sufficient quantity of a kind of honey for the nourishment of the young larva, when hatched, proceeds to close the top with circular bits of rose-leaf; and, thus proceeding, finishes the whole series. This is usually done towards the close of summer; and the young, having passed the period of their larva state, change into that of chrysalis, and remain the whole winter, not making their appearance till pretty late in the ensuing season. This bee is about the size of the common, or honey-bee, but shorter and broader bodied in proportion, and is of a dusky colour above, the lower parts being covered with a bright ferruginous down or hair. In seasons when this species happens to be plentiful, it does considerable injury to the trees which it attacks, large trunks of apparently healthy oaks having been found very materially injured by the numerous trains of cells distributed through them in different parts; thirty, forty, or fifty tubes sometimes lying within a very small distance of each other. In defect of rose-leaves, the cavities are sometimes lined with the leaves of elm, &c. A species, very nearly allied to the preceding, pursues a similar plan of forming a continued series of cylindrical nests with rose or other leaves, rolling them in such a manner as to resemble so many thimbles, the top of each being closed as before. Instead, however, of being placed in the timber of trees, they are laid in horizontal trains, at a certain distance beneath the surface of the ground. Of the villose, or hairy bees, popularly called humble-bees, one of the largest and most common in England is the apis lapidaria of Linnæus, so named from the circumstance of its nest being generally situated in strong or gravelly places. This species is entirely

of a deep black colour, except the end of the abdomen, which is red or orange-coloured, more or less deep in different individuals. The female is of large size, measuring near an inch in length; the male is considerably smaller; and the neuter, or labouring bee, still smaller than the male. The humble-bees in general live in small societies of 40 or 60 together, in an oval or roundish nest, excavated to a small depth beneath the surface of the ground, and formed of branches of moss, compacted together, and lined with a kind of coarse wax. In this nest, which measures from four to six inches in diameter, are constructed several oval cells, which, however, are not the work of the complete insects, but are the cases spun by the larvæ, and in which they remain during their state of chrysalis: the eggs are deposited among heaps of a kind of coarse honey or bee-bread, placed here and there at uncertain intervals; on this substance the larvæ feed during their growing state: lastly, in every nest are placed a few nearly cylindric cells or goblets of coarse wax, and filled with pure honey, on which the complete insects feed. See Plate I. Entomology, fig. 4—6. For the management of bees, see BEE.

APIUM, in botany, a genus of plants, including parsley, smallage, and celery. Class, Pentandria Digynia; natural order of Umbellatæ. Essen. character, cal. general umbel of fewer rays than those of the partial; cor. general uniform; floscules almost all fertile; petals roundish, inflex, equal; stam. filaments simple; anthers, roundish; pist. germ inferior; seeds two, ovate, striated on one side, plane on the other. A. petrosilinum, or common parsley; both the varieties are in use; but it is remarked that the plane-leaved sort is most commonly cultivated, though many prefer the curled kind, because its leaves are most easily distinguished from the æthusa, or fool's parsley, a sort of hemlock, and a poisonous garden weed, which, while young, has great resemblance to the common plane-leaved parsley. Besides, the curled parsley, from its having larger and thicker leaves, and being curiously fimbriated and curled, so as to shew full and double, makes a better appearance in its growth, and is more esteemed by cooks for the purpose of garnishing dishes, &c. It may, however, be necessary to remark, that this sort, as being only a variety, is liable to degenerate to the common plane sort, unless particular care be taken to save the seed always from the perfect, full curled plants. Both the varieties are propagated by seed sown annually in spring, where the plants are to remain; but the plants are biennials, rising from seed sown in March, April, May, and June. A. latifolium, or broad-leafed parsley. The propagation of this species is also by seed sown annually in February, March, April, or May, where the plants are to remain. For this purpose, a spot of light rich earth, in an open exposure, is to be preferred; the seed being sown broad-cast, and raked in, the plants generally appearing in about a month after being sown, and in May or June they require to be thinned and cleared from weeds, which may be performed either by hand or hoe; but the latter is most eligible, as it will stir and loosen the surface of the earth, which may be beneficial to the plants, cutting them out to about six inches distance from each other. In the latter end of July, the roots will mostly have attained a size proper for use, and may be drawn occasionally; but they seldom acquire their full growth till about Michaelmas. This is sometimes called Hamburgh parsley, probably from its being much cultivated about that place. It is chiefly cultivated and esteemed for its large roots, which are white, and carrot-shaped, being long, taper, and of downright growth, often attaining the size and appearance of small or middling parsnips; they boil exceedingly tender and palatable, are very wholesome, and may be used in soup or broth, or to eat like carrots and parsnips, or as sauce to flesh meat. A. dulce, or the common celery. The method of propagation in all the varieties of this sort, is by sowing the seed in the spring, and when the plants have attained six or eight inches in height, transplanting them into trenches, in order to be earthed up on each side as they advance in growth, and have their stalks blanched or whitened, to render them crisp and tender.

APLANATIC, in optics, a term applied by Dr. Blair, professor of astronomy in Edinburgh, to that kind of refraction discovered by himself, which corrects the aberration of the rays of light, and the colour depending upon it, in contradistinction to the word achromatic, which has been appropriated to that refraction, in which there is only a partial correction of colour. See OPTICS. Dr. Blair discovered a mixture of solutions of ammoniacal and mercurial salts, and also some other substances, which produced dispersions proportional to that of glass, with respect to the different colours; and he constructed a compound lens, consisting of a semi-convex one of crown glass, with

its flat side towards the object, and a meniscus of the same materials, with its convex side in the same direction, and its flatter concave next the eye, and the interval between these lenses he filled with a solution of antimony in a certain proportion of muriatic acid. The lens thus adapted did not manifest the slightest vestige of any extraneous colour. He obtained a patent for the invention in 1791.

APLUDA, in botany, a genus of the Polygamia Monoecia class of plants, the common calyx of which is an univalve, bifloral, ovated, concave, loose mucronated glume; the proper glume is bivalve, and placed obliquely; the corolla is a bivalve glume of the length of the cup; there is no pericarpium; the seed, which is single, is involved in the glume of the corolla. Male corol. two valved; female floret sessile; stamina three. Female corol. two valved; one style; one seed, covered. There are four species.

APOCOPE, among grammarians, a figure which cuts off a letter or syllable from the end of a word, as *ingeni* for *ingenii*.

APOCRYPHAL, something dubious, is more particularly applied to certain books not admitted into the canon of scripture. Those are certain books of the Old Testament extant only in Greek, admitted by the church of Rome as canonical, but rejected by the reformed churches as no part of holy writ; such are the books of Judith, Wisdom, Tobit, Baruch, Maccabees, the third and fourth books of Esdras. In this sense apocryphal stands distinguished from canonical, though the Romish church disowns the distinction. Authors are divided as to the origin of the appellation apocryphal, and the reason why it was given to these books. The apocryphal books were not received into the canon, either of the Jews, or ancient Christians, but were first made canonical by a decree of the council of Trent The apocryphal books, according to the sixth article of the church of England, are to be read for example of life and instruction of manners; but it doth not apply them to establish any doctrine.

APOCYNUM, in botany, a genus of the Pentandria Dyginia class and order. Corol. companulate; nectareous filaments five, alternating with the stamina. There are 14 species.

APODES, the name of one of the orders of fishes in the Linnæan distribution of animals. Their character is, that they have no belly fins; there are 12 genera, *viz.*

Ammodytes,	Ophydium,
Anarhichas,	Sternoptyx,
Gymnothorax,	Stomateus,
Gymnotus,	Stylephorus,
Leptocephalus,	Trichiurus,
Muræna,	Xiphias,

which see under the several heads in the alphabet.

APOGEE, in astronomy, that point of the orbit of a planet, or the sun, which is farthest from the earth.

Ancient astronomy, which placed the earth in the centre of the system, was much taken up in ascertaining the apogee and perigee; which the moderns have changed for aphelium and perihelium. See the article APHELIUM, &c.

APOLLONIUS, of Perga, a city in Pamphilia, was a celebrated geometrician, who flourished in the reign of Ptolemy Euergetes, about 240 years before Christ; being about 60 years after Euclid, and 30 years later than Archimedes. He studied a long time in Alexandria under the disciples of Euclid; and afterwards he composed several curious and ingenious geometrical works, of which only his books of Conic Sections are now extant, and even these not perfect. For it appears from the author's dedicatory epistle to Eudemus, a geometrician in Pergamus, that this work consisted of eight books; only seven of which however has come down to us.

From the Collections of Papus, and the Commentaries of Eutocius, it appears that Apollonius was the author of various pieces in geometry, on account of which he acquired the title of the great geometrician. His Conics was the principal of them. Some have thought that Apollonius appropriated the writings and discoveries of Archimedes; Heraclius, who wrote the life of Archimedes, affirms it; though Eutocius endeavours to refute him. Although it should be allowed a groundless supposition, that Archimedes was the first who wrote upon conics, notwithstanding his treatise on conics was greatly esteemed, yet it is highly probable that Apollonius would avail himself of the writings of that author, as well as others who had gone before him; and, upon the whole, he is allowed the honour of explaining a difficult subject better than had been done before, having made several improvements, both in Archimedes's problems, and in Euclid. His work upon conics was doubtless the most perfect of the kind among the ancients, and

in some respects among the moderns also. Before Apollonius, it had been customary, as we are informed by Eutocius, for the writers on conics to require three different sorts of cones to cut the three different sections from; *viz.* the parabola from a right-angled cone, the ellipse from an acute, and the hyperbola from an obtuse cone; because they always supposed the sections made by a plane cutting the cones to be perpendicular to the side of them: but Apollonius cut his sections all from any one cone, by only varying the inclination or position of the cutting plane; an improvement that has been followed by all other authors since his time. But that Archimedes was acquainted with the same manner of cutting any cone is sufficiently proved, against Eutocius, Pappus, and others, by Guido Ubaldus, in the beginning of his Commentary on the second book of Archimedes's Equiponderantes, published at Pisa in 1588. See CONIC SECTIONS.

The first four books of Apollonius's conics only have come down to us in their original Greek language; but the next three, the 5th, 6th, and 7th, in an Arabic version; and the 8th not at all. These have been commented upon, translated, and published by various authors. Pappus, in his Mathematical Collections, has left some account of his various works, with notes and lemmas upon them, and particularly on the Conics. And Eutocius wrote a regular elaborate commentary on the propositions of several of the books of the Conics.

A neat edition of the first four books in Latin was published by Dr. Barrow, in 4to. at London, in 1675. A magnificent edition of all the books was published in folio, by Dr. Halley, at Oxford, in 1710; together with the Lemmas of Pappus, and the Commentaries of Eutocius. The first four in Greek and Latin, but the latter four in Latin only, the 8th book being restored by himself.

APOLOGUE, in matters of literature, an ingenious method of conveying instruction by means of a feigned relation, called a moral fable.

The only difference between a parable and an apalogue is, that the former, being drawn from what passes among mankind, requires probability in the narration: whereas the apalogue, being taken from the supposed actions of brutes, or even of things inanimate, is not tied down to the strict rules of probability. Æsop's fables are a model of this kind of writing.

APONOGETON, in botany, a genus of the Dodecandria Tetragynia. Ament, composed of scales; no calyx, no corol.; capsules four; three seeded. There are four species.

APOPHTHEGM, a short, sententious, and instructive remark, pronounced by a person of distinguished character. Such are the apophthegms of Plutarch, and those of the ancients collected by Lycosthenes.

APOPHYSIS, in anatomy, an excrescence from the body of a bone, of which it is a true continuous part, as a branch is of a tree.

APOTHECARY, one who practises the art of pharmacy, or that part of physic which consists in the preparation and composition of medicines.

A youth intended for this profession should be a pretty good scholar, and have such a knowledge in the Latin tongue, as to be able to read the best writers upon the subject of botany, pharmacy, anatomy, and medicine. In London, the apothecaries are one of the city companies, and by an act, which was made perpetual in the ninth year of George I. are exempted from serving upon juries, or in ward and parish offices. They are obliged to make up their medicines according to the formulas described in the College Dispensatory, and are liable to have their shops visited by the censors of the college, who are empowered to destroy such medicines as they think not good. In Pennsylvania, and we believe the United States generally, no obligation of this kind is imposed. Any person, however ignorant of the qualities and properties of medicines, or unskilful in the preparation of them, may nevertheless establish himself as an apothecary; the consequence is, the occurrence of many accidents; the injudicious application of drugs; and, as he is amenable to no authority, the consequent adulteration of his compounds.

The apothecaries have a Hall in Blackfriars, London, where there are two fine laboratories, from which all the surgeons' chests are supplied with medicines for the royal navy. In China, they have a singular mode of dispensing their medicines. In the public squares of their cities there is a very high stone pillar, on which are engraven the names of all sorts of medicines, with the price of each; and when the poor stand in need of any relief from physic, they go to the treasury, where they receive the price each medicine is rated at.

APOTHEOSIS, in antiquity, a ceremony, by which the ancient Romans compli-

mented their emperors and great men, after their death, with a place among the gods. It is described as follows: after the body of the deceased had been burnt with the usual solemnities, an image of wax, exactly resembling him, was placed on an ivory couch, where it lay for seven days, attended by the senate and ladies of the highest quality in mourning; and then the young senators and knights bore the bed of state through the Via sacra to the old Forum, and from thence to the Campus Martius, where it was deposited upon an edifice built in form of a pyramid. The bed being thus placed, amidst a quantity of spices and other combustibles, and the knights having made a procession in solemn measure round the pile, the new emperor, with a torch in his hand, set fire to it, while an eagle, let fly from the top of the building, and mounting in the air with a firebrand, was supposed to convey the soul of the deceased to heaven, and thenceforward he was ranked among the gods.

APOTOME, in geometry, the difference between two incommensurable lines: thus, E C, (Plate Miscel. fig. 6.) is the apotome of A C and A B.

If we suppose A C $= a$, and A B $= b$. then will their apotome be $a - \sqrt{b}$; or, in numbers, $2 - \sqrt{3}$. Hence also the difference between the side A C $= 2$ (fig. 7.) of an equilateral triangle A B C, and the perpendicular B D $= \sqrt{3}$ is an apotome, *viz.* $= 2 - \sqrt{3}$. And universally, if A C (fig. 8.) be a semi-parabola, whose axis is A B, and its latus rectum $= 1$, and if A D be a tangent to the vertex at A, and this be divided into the parts A $a = 2$, A $b = 3$, A $c = 5$, A $d = 6$, &c. and perpendiculars a 1, b 2, c 3, d 4, &c. be drawn, these will be, from the nature of the curve, $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, $\sqrt{6}$, &c. respectively: and so $\frac{1}{2}$ A a $(= 1)$ — a 1, will be $1 - \sqrt{2}$: A $a - b$ 2 will be $2 - \sqrt{3}$, &c. by which means you will have an infinite series of different apotomes.

Apotome, in music, the difference between a greater and lesser semi-tone, expressed by the ratio 128 : 125.

APPARATUS, a term used to denote a complete set of instruments, or other utensils, belonging to any artist or machine: thus we say, a surgeons' apparatus, a chemist's apparatus, the apparatus of the air-pump, microscope, &c.

APPARENT, among mathematicians and astronomers, denotes things as they appear to us, in contradistinction from real or true: thus we say, the apparent diameter, distance, magnitude, place, figure, &c. of bodies.

APPARITOR, among the Romans, a general term to comprehend all attendants of judges and magistates appointed to receive and execute their orders. Apparitor, with us, is a messenger, that serves the process of a spiritual court, or a beadle in an university, who carries the mace.

APPAUMEE, in heraldry, denotes one hand extended with the full palm appearing, and the thumb and fingers at full length.

APPEAL, in law, the removal of a cause from an inferior to a superior court or judge, when a person thinks himself aggrieved by the sentence of the inferior judge. Appeals lie from all the ordinary courts of justice to the House of Lords. In ecclesiastical causes, if an appeal is brought before a bishop, it may be removed to the archbishop; if before an archdeacon, to the Court of Arches, and thence to the archbishop; and from the archbishop's court to the king in chancery.

Appeal, in common law, is taken for the accusation of a murderer by a person who had interest in the party killed; or of a felon by an accomplice. It is prosecuted either by writ or by bill: by writ, when a writ is purchased out of the Chancery by one person against another, commanding him to appeal some third person of felony, and to find pledges for doing it effectually; by bill, when the person himself gives in his accusation in writing, offering to undergo the burden of appealing the person therein named.

In military affairs, an appeal might formerly be made by the prosecutor, or prisoner, from the sentence or jurisdiction of a regimental to a general court-martial. At present no soldier has a right to appeal, except in cases where his immediate subsistence is concerned.

APPEARANCE, in law, signifies a defendant's filing a common or special bail on any process issued out of a court of judicature. In actions by original, appearances are entered with the philazer of the county; and by bill, with the prothonotary. Defendants may appear in person, where the party stands in contempt, for the court will not permit him to appear by attorney: also in capital and criminal cases: where an act of parliament requires that the party should appear in person, and likewise in appeal, or on attachment: by attorney, in all actions, real, personal, and mixed, and for any crime whatever under the degree of capital, by

favour of the court: by guardian and next friend, when under age.

APPELLATIVE, in grammar, a noun, or name, which is applicable to a whole species or kind, as man, horse; in contradistinction to a proper name.

APPELLOR, or Appellant, in law, he who has committed some felony or other crime, which he confesses and appeals, that is, accuses his accomplices.

APPENDANT, in law, any thing that is inheritable, belonging to some more worthy inheritance, as an advowson, common, or court, may be appendant to a manor, land to an office, &c. but land cannot be appendant to land, for both are corporeal inheritances, and one thing corporeal cannot be appendant to another.

APPLE, a well-known fruit, consisting of a rind, pill, or skin; the pulp, or parenchyma; the branchery, or seed-vessels; and the core. See Pyrus.

APPLICATION, the act of applying one thing to another, by causing them to approach, or bringing them nearer together. Thus a longer line or space is measured by the application of a less, as a foot or yard by an inch, &c.; and motion is determined by successive application of any thing to different parts of space. Application is sometimes also used both in arithmetic and geometry, for the operation of division, or for that which corresponds to it in geometry. Thus 20 applied to, or divided by 4, *i. e.* $\frac{20}{4}$, gives 5. And a rectangle $a\,b$ applied to a line, c, gives the fourth proportional $\frac{a\,b}{c}$, or another line, as d, which, with the given line c, will contain a rectangle $c\,d = a\,b$.

Application, in geometry, denotes the act of placing one figure upon another, in order to determine their equality or inequality. In this way Euclid, and other geometricians, have demonstrated some of the primary and fundamental propositions in elementary geometry. Thus it is proved, that two triangles, having two sides of the one equal respectively to two sides of the other, and the two included angles equal, are equal in all respects; and two triangles, having one side and the adjacent angles of the one respectively equal to one side, and the adjacent angles of the other, are also in the same mode of application shewn to be equal. Thus also it is demonstrated that a diameter divides the circle into two equal parts; and that the diagonal divides a square or parallelogram into two equal parts. The term is also used to signify the adaptation of one quantity to another, in order to their being compared, the areas of which are the same, but their figures different. Thus Euclid shews how, on a right line given, to apply a parallelogram that shall be equal to a right-lined figure given.

Application *of one science to another*, signifies the use that is made of the principles of the one for augmenting and perfecting the other. As there is a connection between all the arts and sciences, one of them may be made subservient to the illustration and improvement of the other; and to this purpose algebra has been applied to geometry, and geometry to algebra, and both to mechanics, astronomy, geography, navigation, &c. See Algebra, *application of.*

Application *of algebra and geometry to mechanics* is founded on the same principles as the application of algebra to geometry. It consists principally in representing, by equations, the curves described by bodies in motion, by determining the equation between the spaces which the bodies describe when actuated by any forces, and the times employed in describing them. As a familiar instance, we may refer to the article Acceleration, where the perpendiculars of triangles represent the times, the bases, the velocities, and the areas the spaces described by bodies in motion, a method first invented by Galileo. As lines and figures may be treated of algebraically, it is evident in what way the principles of geometry and algebra may be applied to mechanics, and indeed to every branch of mixt mathematics.

Application *of mechanics to geometry* consists in the use that is made of the centre of gravity of figures, for determining the contents of solid bodies described by those figures.

Application *of geometry and astronomy to geography* consists in determining the figure and magnitude of the earth; in determining the positions of places by observations of latitudes and longitudes; and in determining, by geometrical operations, the positions of such places as are not far distant from one another.

Application *of geometry and algebra to natural philosophy* was invented chiefly by Sir Isaac Newton, and upon this application are founded all the mixed sciences of mathematical and natural philosophy. Here a single obesrvation or experiment will frequently produce a whole science, or branch of science. Thus when it is proved by experiment that the rays of

light in reflecting, make the angle of incidence equal to the angle of reflection, we deduce the whole science of catoptrics; for, this fact being established, catoptrics becomes a science purely geometrical, since it is reduced to the comparison of angles and lines given in position.

APPOINTEE, in heraldry, the same as aguisée: thus we say, a cross appointée, to signify that which has two angles at the end cut off, so as to terminate in points.

APPORTIONMENT, in law, the division of a rent into parts, in the same manner as the land out of which it issues is divided: for example, if a person leases three acres of land for a certain rent, and afterwards grants away one acre thereof to another, the rent shall be apportioned between them.

APPOSITION, in grammar, the placing two or more substantives together, in the same case, without any copulative conjunction between them; as, *ardebat Alexim delicias domini*.

APPRAISING, the valuing or setting a price on goods. This is usually done by a sworn appraiser, who, if he values the goods too high, is obliged to take them at the price appraised.

APPREHENSION, in logic, the first or most simple act of the mind, whereby it perceives, or is conscious of some idea: it is more usually called perception.

APPRENTICE, a young person bound by indenture to some tradesman, in order to be instructed in the mystery or trade. By the laws of England, a master may be indicted for not providing for, or for turning away, his apprentice: and upon complaint from a master, that he neglects his duty, an apprentice may be committed to Bridewell, or be bound over to the sessions. Apprentices may be bound to husbandmen, or even to gentlemen of fortune and clergymen, who, as well as tradesmen, are compellable to take the children of the poor, under a penalty of 10*l.* And the church-wardens and overseers, with the consent of two justices, may bind them till the age of 21 years. Justices may compel certain persons under age to be bound apprentices, and on refufal may commit them. Apprentices may be discharged on reasonable cause, either at their own request, or that of their masters. If any, whose premium has been less than ten pounds, run away from their masters, they are compellable to serve out the time of absence, or give satisfaction for it, any period within seven years after the expiration of the original contract. Indentures are to be stamped, and are chargeable with several duties by act of parliament.

APPRENTICESHIP, denotes the servitude of an apprentice, or the duration of his indenture. The competition in several employments is restrained to a smaller number than would otherwise be disposed to enter into them, partly by the limitation of the number of apprentices, which attends the exclusive privilege of incorporated trades; and partly by the long term of apprenticeship, which increases the expense of education. Seven years seem formerly to have been, all over Europe, the usual term established for the duration of apprenticeships in the greater number of incorporated trades. Such incorporations were anciently called universities, which is the proper Latin name for any incorporation whatever. The university of smiths, the university of tailors, &c. are expressions commonly occurring in the old charters of ancient towns. When those particular incorporations, which are now peculiarly called universities, were first established, the term of years during which it was necessary to study, in order to obtain the degree of Master of Arts, appears evidently to have been copied from the term of apprenticeship in common trades, of which the incorporations were much more ancient. As to have wrought seven years under a master, properly qualified, was necessary to entitle any person to become a master, and to have himself apprentices, in a common trade, so to have studied seven years under a master properly qualified, was necessary to entitle him to become a master, teacher, or doctor, (words anciently synonymous,) to study under him. By the 5th of Elizabeth, commonly called the statute of apprenticeship, it was enacted, that no person should, for the future, exercise any trade, craft, or mystery, at that time exercised in England, unless he had previously served to it an apprenticeship of seven years at least; and thus, what before had been the bye-law of many particular corporations, became in England the general and public law of all trades carried on in market-towns. To country villages the term of seven years apprenticeship doth not extend; but the limitation of this statute to trades exercised before it was passed has given occasion to several distinctions, which, considered as rules of police, appear as foolish as can well be imagined. A coachmaker, for instance, has no right to make, or employ journeymen for making, coach-wheels: but he must buy them of a master wheel-right, this latter trade having

been exercised in England before the 5th of Elizabeth. But a wheel-wright, though he has never served an apprenticeship to a coachmaker, may, by himself or journeyman, make coaches, because this trade, being of a later origin, is not within the statute. Thus also the manufactures of Manchester, Birmingham, and Wolverhampton, are, many of them, upon this account, not within the statute, not having been exercised in England before the 5th of Elizabeth.

The regulations of apprenticeship in Ireland are upon a different footing, and somewhat less illiberal than in England. Prohibitions, similar to those of the statute of the 5th of Elizabeth, obtain in all corporate towns, by authority of bye-laws of the several corporations: but these prohibitions extend only to natives of Ireland; for, by a regulation made by the lord lieutenant and privy-council, having in this instance, by 17 and 18 Car. II. the force of a law, all foreigners and aliens, as well persons of other religious persuasions as Protestants, who are merchants, traders, artificers, &c. shall, upon coming to reside in a city, walled town, or corporation, and paying twenty shillings, by way of fine, to the chief magistrate and common-council, or other persons authorised to admit freemen, be admitted to the freedom of that city, &c. and to the freedom of guilds of their respective trades, with the full enjoyment of all privileges of buying, selling, working, &c.; and any magistrate refusing to admit foreigners, so applying, shall be disfranchised.

In Scotland, there is no general law which regulates universally the duration of apprenticeships. The term is different in different corporations; where it is long, a part of it may generally be redeemed by paying a small fine. In most towns, too, a very small fine is sufficient to purchase the freedom of any corporation. The weavers of linen and hempen cloth, the principal manufactures of the country, as well as all other artificers subservient to them, wheel-makers, reel-makers, &c. may exercise their trades in any town corporate, without paying any fine. In all towns corporate, all persons are free to sell butchers' meat upon any lawful day of the week. Three years are, in Scotland, a common term of apprenticeship, in some very nice trades; and, in general, there is no country in Europe, in which corporation laws are so little oppressive. In France the duration of apprenticeships is different in different towns, and in different trades. In Paris, 5 years are the term required in a great number; and before any person can be qualified to exercise the trade as a master, he must, in many of them, serve 5 years more as a journeyman. During this latter time, he is called the companion of his master, and the term itself is called his companionship. The institution of long apprenticeships, says Dr. Smith, can give no security that insufficient workmanship shall not frequently be exposed to sale; nor has it any tendency to form young people to industry. Apprenticeships were altogether unknown to the ancients: the Roman law is perfectly silent with regard to them. There is no Greek or Latin word, which expresses the idea we now annex to the word apprentice.

Long apprenticeships are altogether unnecessary. The arts, which are much superior to common trades, such as those of making clocks and watches, contain no such mystery as to require a long course of instruction. In the common mechanic trades, the lessons of a few days might certainly be sufficient. The dexterity of hand, indeed, even in common trades, cannot be acquired without much practice and experience. But a young man would practise with much more diligence and attention, if, from the beginning, he wrought as a journeyman, being paid in proportion to the little work which he could execute, and paying, in his turn, for the materials which he might sometimes spoil through awkwardness and inexperience. His education would generally in this way be more effectual, and always less tedious and expensive. The master, indeed, would be a loser; he would lose all the wages of the apprentice, which he now saves for seven years together. In the end, perhaps, the apprentice himself would be a loser; in a trade so easily learnt he would have more competitors; and his wages, when he came to be a complete workman, would be much less than at present. The same increase of competition would reduce the profits of the masters, as well as the wages of the workmen: the trades, the crafts, the mysteries, would all be losers; but the public would be a gainer, the work of all artificers coming in this way much cheaper to market.

We cannot conclude this article better, than by inserting an admirable paper on the subject of apprentice laws, drawn up, and printed for private circulation, by a gentleman of high legal authority, and member of parliament, entitled "A few Opinions of some great and good Men, and sound Lawyers, on the Apprentice Laws of Queen Elizabeth, applicable to the Æra of 1806-7."

Lord Mansfield, in his arguments on the case, Rennard and Chase, brewers. 1 Bur. Rep. p. 2, says, "It hath been well observed that this act (*viz.* 5 Eliz. chap. 4.) is,

1. A penal law.
2. It is a restraint on natural right.
3. It is contrary to the general right given by the common law of this kingdom.
4. The policy upon which this act was made is from experience become doubtful. Bad and unskilful workmen are rarely prosecuted. This act was made early in the reign of Queen Elizabeth, when the great number of manufacturers, who took refuge in England after the duke of Alva's prosecution, had brought trade and commerce with them, and enlarged our notions. The restraint introduced by this law was thought unfavourable; and the judges, by a liberal interpretation, have extended the qualification for exercising the trade much beyond the letter of it, and confined the penalty and prohibition to cases precisely within the express letter." Burn's Justice, vol. i. Art. Apprentices.

3d Modern Reports, p. 317. Judge Dolben, in delivering his opinion, said, that "No encouragement was ever given to prosecutions upon the statute 5 Eliz. and that it would be for the common good, if it were repealed; for no greater punishment can be to the seller, than to expose to sale goods ill-wrought, for by such means he will never sell more."

2 Salk. 613. The Queen v. Maddox.—It was held by the court, "that upon indictments upon the statute of 5 Eliz. the following of a trade for seven years to be sufficient without any holding; this being a hard law." And so held in Lord Raymond, 738.

Burn's Justice.—"So detrimental was this statute thought, that by 15 Car. II. all persons spinning, or making cloth of hemp or flax, or nets for fishing, or storin, or cordage, might exercise those trades without serving apprenticeships. And so little did the legislature, at subsequent periods, think that any benefit was to be derived from the statute of 5 Eliz. or that manufactures were made better, or improved by this restraint; and the minds of men being more liberal, that trade should, as much as possible, be flung open; it is enacted by 6 and 7 William III. that any apprentice discovering two persons guilty of coining, so as they are convicted, shall be deemed a freeman, and may exercise his trade as if he had served out his time."

And, in order still stronger to shew how little the legislature esteemed the seven years binding ameliorated manufactures, it is enacted, by 3 George III. cap. 8, that "All officers, marines, and soldiers, who have been employed in his majesty's service, and not deserted, may exercise such trades as they are apt for, in any town or place."

So dangerous and fatal has been the evil of combinations and conspiracies among journeymen, that in particular instances, as in trades where many hands are required and very little skill, as dyeing, and such like, the legislature have made express laws to give relief to masters. See 17 Geo. III. cap. 33.; which enables dyers, in Middlesex, Essex, Surrey, and Kent, to employ journeymen who have not served apprenticeships. And to such a pitch has this mischief in the West Riding of Yorkshire increased, by the conspiracies facilitated by the act of 5 Eliz. that it goes to the total annihilation of our staple manufactures, and every other trade which hopes for success, not only by the home, but from foreign consumption. See the report from the committee of the House of Commons, on the woollen trade and manufacture of these kingdoms, made in the last session of parliament, 4th July, 1806.

After stating the above, let us quote the words of the immortal Lord Chief Justice Coke on this point.—"That, at the common law, no man could be prohibited from working in any lawful trade: for the law abhors idleness, the mother of all evil—*Otium omnium vitiorum mater*—and especially in young men, who ought in their youth (which is their seed time) to learn lawful sciences and trades, which are profitable to the commonwealth, whereof they might reap the benefit in their old age: for 'idle in youth, poor in age'."

And therefore the common law abhors all monopolies, which prohibit any from working in any lawful trade. And that appears in 2 Hen. V. 5 b. A dyer was bound not to use the dyer's craft for two years: and there Judge Hall held, "that the bond was against the common law: and by G—d, if the plaintiff was here, he should go to prison till he paid a fine to the king." And vide 7 Edw. III. 65 b. "And, if he who takes upon himself to work is unskilful, his ignorance is a sufficient punishment to him, for *imperitia est maxima mecanicorum pœna; et quilibet quæ rit in quâlibet arte peritos:* which is, 'that want of skill is the greatest punishment of mechanics; for every body will employ those that are the best skilled in their business.' And if any one takes upon himself to work, and spoils it, an action on the case lies against him."

Having observed thus much, and stated the opinions of two such great men as Lord Coke and Lord Mansfield, we can only add one dixit of Lord Coke's, that "acts of parliament, which are made against the freedom of trade, merchandizing, handicrafts, and mysteries, never live long." 4th Inst. 31.

It is to be observed that this very great check upon trade, by not being able to employ any hands that are able to perform the work required, and especially in those trades which are so easily learnt in a very short space of time, greatly enhances the prices of all articles, and that at a time when population is daily increasing, and the demand proportionably increasing. And this statute is not only a restraining statute, but also an enabling statute, as it empowers the workmen to enter into combinations against their masters, and to dictate their own terms, encouraging vice, idleness, and drunkenness; demands being made on the masters for an increase of wages; those demands supported by dangerous combinations and conspiracies, and extorted by threats. And such increase, when obtained, not applied for the wholesome purpose of supporting themselves and their families, but to that very destructive purpose, ruinous to their families, and highly detrimental to the public at large, the enabling of the parties to spend more days of the week in idleness, drunkenness, vice, and immorality. In many manufactures, so much money is extorted by the journeymen, by means of these combinations, from their employers, that the journeymen will work but three days in the week; so that 600 are necessarily required to do the work that 300 might do.

Until these laws, restricting the binding of apprentices, are repealed, all laws made for the prevention of combinations among workmen, can be of no avail, and will remain a dead letter in the law books: as in this free country, (however that freedom may be limited as to the checking of masters binding apprentices), no law on this point can be so worded, that the art, wickedness, and ingenuity of men, will not contrive to defeat. A bad and absurd law is made, *viz.* the "Apprentice Act," which, by the extension of trade, is found detrimental to trade; and then, to do away the mischiefs of that law, another absurd law is made, *viz.* the law to prevent combination,—so that mischief is heaped upon mischief, and absurdity upon absurdity. Trade should be as free as the air we breathe. This is an axiom, the truth of which every day convinces us.

APPROACHES, in fortification, the works thrown up by the besiegers, in order to get nearer a fortress, without being exposed to the enemy's cannon: such, in a more particular manner, are the trenches, which should be connected by parallels, or lines of communication.

This is the most difficult part of a siege, and where most lives are lost. The ground is disputed inch by inch, and it is of the utmost importance to make the approaches with great caution, and to secure them as much as possible.

The besieged frequently make counter-approaches, to interrupt and defeat the enemy's approaches.

APPROPRIATION, the annexing a benefice to the proper and perpetual use of a religious house, bishopric, college, &c. Where the king is patron, he may make appropriations himself; but in other cases, after obtaining his licence in chancery, the consent of the ordinary, patron, and incumbent, is requisite. Appropriations cannot be assigned over, but those to whom they are granted may make leases of the profits. There are in England 2845 impropriations.

APPROVER, in law, a person, who, being indicted of treason or felony, for which he is not in prison, confesses the indictment: and being sworn to reveal all the treasons and felonies he knows, enters before the coroner his appeal against all his partners in the crime. All persons may be approvers, except peers of the realm, persons attainted of treason or felony, or out-lawed, infants, women, persons *non compos*, or in holy orders.

APPROXIMATION, in arithmetic and algebra, the coming nearer and nearer to a root, or other quantity sought, without expecting to be ever able to find it exactly. There are several methods for doing this, to be found in mathematical books, being nothing but infinitely converging series, some approaching quicker, others slower towards the truth.

By such an approximation the value of a quantity may be found, though not to the utmost degree of exactness, yet sufficiently so for practice. Thus $\sqrt{2} = 1.41421356$, &c. $=$ the approximating series $1 + \frac{4}{10} + \frac{1}{100} + \frac{4}{1000} + \frac{2}{10000} +$. &c. or supposing $x = \frac{1}{10}$, equal to the series $1 \times \frac{4}{x} + \frac{1}{x^2} + \frac{4}{x^3} + \frac{2}{x^4} +$, &c. $= 1 + 4x^{-1} + x^{-2} + 4x^{-3} + 2x^{-4} +$, &c.

Again, supposing $a^2 + b$ to be a non-quadrate number, and $a^3 + b$ to be a non-cubic one; then will $\sqrt{a^2 + b} = a +$

$\frac{a\,b}{2a^2+\frac{1}{2}b}$, and $\sqrt[3]{a^3+b} = a + \frac{a\,b}{3\,a^3+b}$ $= \frac{1}{2}a + \sqrt{\frac{1}{4}a^3 + \frac{b}{3a}}$ nearly.

There is a general method of investigating the value of such series, for which see SERIES.

APPULSE, in astronomy, the approach of a planet towards a conjunction with the sun, or any of the fixed stars. The appulses of the planets to the fixed stars have always been of great use to astronomers, in order to fix the places of the former. The ancients, wanting an easy method of comparing the planets with the ecliptic, which is not visible, had scarce any other way of fixing their situations, but by observing their tract among the fixed stars, and remarking their appulses to some of those visible points. Dr. Halley has published a method of determining the places of the planets, by observing their near appulses to the fixed stars.

APPURTENANCES, in common law, signify things corporeal and incorporeal, that appertain to another thing as principal; as hamlets to a manor, and common of pasture and fishery. Things must agree in nature and quality to be appurtenent, as a turbary, or a seat in a church, to a house.

APRICOT, in botany, a species of prunus, with rosaceous flowers, and a delicious fleshy fruit, of a roundish figure. See PRUNUS.

APRON, in gunnery, the piece of lead which covers the touch-hole of a cannon.

The dimensions of aprons are as follows: *viz.* for 42, 32, and 24 pounders, 15 inches by 13; for 18, 12, and 9 pounders, 12 inches by 10; and for cannon of less calibre, 10 inches by 8. They are tied by two strings of white marline.

APSIS, in astronomy, a term used indifferently for either of the two points of a planet's orbit, where it is at the greatest or least distance from the sun or earth. Hence the line connecting these points is called the line of the apsides.

APTENODYTES, in ornithology, *penguin*, a genus of the order Anseres. The bill is straight, rather compressed, and sharp along the edges; the upper mandible is obliquely sulcated, lengthwise; feet palmated, shackled; wings fin-shaped, and without quill-feathers; feet fettered, four-toed. This genus resembles the alca in colour, food, stupidity, eggs, nest, positions of legs behind the equilibrium, and consequent erect posture. They are totally unfit for flight, but swim dexterously; nostrils linear, hid in the groove of the bill, palate as well as the tongue beset with a few rows of conic, retroflected, stiff papillæ; wings covered with a strong broad membrane; tail short, wedged, the feathers very rigid. There are nine species according to Latham, but Gmelin enumerates eleven.

This genus of birds seems to hold the same place in the southern parts of the world as the awks do in the northern, and are by no means to be confounded the one with the other, however authors may differ in opinion in respect to this matter. The penguin is seen only in the temperate and frigid zones, on that side of the equator which it frequents; and the same is observed of the awk in the opposite latitudes; and neither of the genera has yet been observed within the tropics. The awk has true wings and quills, though small; the penguin mere fins only, instead of wings. This last has four toes on each foot; but the former only three. The penguin, while swimming, sinks quite above the breast; the head and neck only appearing out of the water, rowing itself along with its finny wings, as with oars; while the awk, in common with most other birds, swims on the surface. Several other circumstances peculiar to each might be mentioned; but we trust the above will prove fully sufficient to characterize this genus. The bodies of the penguin tribe are commonly so well and closely covered with feathers, that no wet can penetrate; and as they are in general excessively fat, these circumstances united secure them from the cold. They have often been found above seven hundred leagues from land; and frequently on the mountains of ice, on which they seem to ascend without difficulty, as the soles of their feet are very rough, and suited to the purpose.

Aptenodytes antarctica, is full 25 inches long, and weighs eleven or twelve pounds: it inhabits the south sea from 48° to the antarctic circle, and is frequently found on the ice mountains and islands on which it ascends. It is a numerous tribe; and they were found in great plenty in the Isle of Desolation.

The black-footed penguin is found in the neighbourhood of the Cape of Good Hope, but particularly in Robbean or Penguin Isles, near Saldanic Bay. Like all the genus, this is an excellent swimmer and diver; but hops and flutters in a strange and aukward manner on the land, and, if hurried, stumbles perpetually; and frequently runs for some distance like a qua-

[illegible] the auk

druped, making use of the wings instead of legs, till it can recover its upright posture; crying out at the same time like a goose, but in a much hoarser voice. It is said to clamber some way up the rocks in order to make a nest, in doing which it has been observed to be assisted with the bill. The eggs are two, and esteemed at the Cape very delicious.

Aptenodytes chrysocome. This beautiful species measures twenty-three inches in length. The bill is three inches long; the colour of it red, with a dark furrow running along on each side to the tip; the upper mandible is curved at the end, the under obtuse; irides of a dull red; the head, neck, back, and sides are black; over each eye a stripe of pale yellow feathers, which lengthens into a crest behind, of near four inches in length: the feathers on each side of the head, above this stripe, are longer than the rest, and stand upward, while those of the crest are decumbent, but can be erected on each side at will; the wings, or rather fins, are black on the outside, edged with white; on the inside white; the breast, and all the under parts, white; the legs are orange: claws dusky. The female has a streak of pale yellow over the eye, but it is not prolonged into a crest behind as in the male. Inhabits Falkland's Islands, and was likewise met with in Kirguelin's Land or Isle of Desolation, as well as at Van Diemen's Land, and New Holland, particularly in Adventure Bay. Are called Hopping Penguins and Jumping Jacks, from their action of leaping quite out of the water, on meeting with the least obstacle, for three or four feet at least; and indeed, without any seeming cause, do the same frequently, appearing chiefly to advance by that means. This species seems to have a greater air of liveliness in its countenance than others, yet is in fact a very stupid bird, so much so, as to suffer itself to be knocked on the head with a stick, when on land. When angered, it erects its crest in a beautiful manner. These birds make their nests among those of the pelican tribe, living in tolerable harmony with them; and lay seldom more than one egg, which is white, and larger than that of a duck. They are mostly seen by themselves, seldom mixing with other penguins, and often met with in great numbers on the outer shores, where they have been bred. Are frequently so regardless as to suffer themselves to be taken by the hand. The females of this species lay their eggs in burrows, which they easily form of themselves with their bills, throwing out the dirt with their feet. In these holes the eggs are deposited on the bare earth. The general time of sitting is in October; but some of the species, especially in the colder parts, do not sit till December, or even January. How long they sit is not known.

Aptenodytes magellanica, inhabits the Straits of Magellan, Staaten Land, Terra del Fuego, and the Falkland isles; is a very numerous species, and is often seen by thousands, retiring by night to the highest parts of the islands. Its voice is not much unlike the braying of an ass. It is not a timid bird, for it will scarcely get out of the way of any one; but will rather attack and bite a person by the legs. They were killed by hundreds by the crews of Captain Cooke's expedition, and were found not unpalatable food. They often mix with the sea-wolves, among the rushes, burrowing in holes like a fox. When they swim, only the neck and shoulders appear out of the water, and they advance with such agility, that no fish seems able to follow them; if they meet with any obstacle, they leap four or five feet out of the water; and dipping into it again continue their rout. It is supposed by Latham that Penrose alludes to this species, of which, he says the chief curiosity is the laying their eggs; this they do in collective bodies, resorting in incredible numbers to certain spots, which their long residence has freed from grass, and to which were given the name of towns. The eggs are rather larger than those of a goose, and are laid in pairs. They lay some time in November, driving away the albatrosses, which have hatched their young in turn before them.

Aptenodytes patachonica. This is the largest of the genus yet known, being four feet three inches in length; and stands erect at least three feet; the weight forty pounds. This species was first met with in Falkland Islands, and has also been seen in Kerguelen's Land, New Georgia, and New Guinea. M. Bougainville caught one which soon became so tame as to follow and know the person who had care of it; it fed on flesh, fish, and bread, but after a time grew lean, pined away, and died. The chief food, when at large, is thought to be fish; the remains of which, as well as crabs, shell-fish, and molluscæ, were found in the stomach. This species is the fattest of the tribe; most so in January, when they moult. Supposed to lay and sit in October. Are met with in the most deserted places. Their flesh is black, though not very unpalatable. This has been considered as a solitary species, but has now and then been met with in com-

siderable flocks. They are found in the same places as the papuan penguins, and not unfrequently mixed with them; but in general show a disposition of associating with their own species. See Plate III. Aves. fig. 6.

APTERA, in the Linnæan system of zoology, the seventh and last order of Insects, the distinguishing characteristic of which is, that the insects comprehended in it have no wings. Of this order there are three divisions. In A. the insects are distinguished by having six legs; head distinct from the thorax: there are five genera; *viz.* the

Lepisma,	Pulex,
Pediculus,	Termes.
Podura,	

In the division B, the insects have from 8 to 14 legs; head and thorax united: of these there are eight genera; *viz.* the

Acarus,	Monoculus,
Aranea,	Oniscus,
Cancer,	Phalangium,
Hydrachna,	Scorpio.

In the division C, the legs are numerous; head distinct from the thorax; of which there are two species; *viz* the

Julus, and
Scolopendra.

This order comprehends all kinds of spiders, the lice of different animals, scorpions and crabs. Upon these we may make a few general observations. The nets spread out by spiders, to catch their prey, are composed of similar materials to the silk of the silk-worm, and are also spun from the animal's body. The cobwebs of the gossamer are frequently seen floating in the air in a sunny day, snd are sometimes so abundant as to fall in showers. Each of these has been compared to a balloon transporting the little aeronaut that formed it, by means of its specific lightness. This species of spider attaching its first formed thread to the leaf or branch of a tree, by dropping to a certain distance lengthens it, then climbs up the thread, and dropping again, draws out another, and so on, till a sufficient quantity of this silk is formed to buoy the spider up in the air. He then separates the whole from the leaf, and running down to his seat at the bottom, trusts himself and his balloon to the mercy of the wind. Many species of spiders effect the same thing by attaching themselves to an eminence by their claws, and after ejecting a sufficient quantity of web, which is wafted onwards by the wind, they suddenly relax their hold and appear to spring into the air. By this method these animals are transported from tree to tree, and from wood to wood in search of food. The cobwebs that are spread over the surface of the grass, and that offer so beautiful an object to the eye early in the summer's morning, through the brilliancy of the dew-drops formed and suspended on their silken threads, and the reflexion of the sun's rays from each, are the work of another species of spiders.

The different kinds of lice are exceedingly numerous, almost every kind of animal having its particular sort of vermin. They are all carnivorous, or perhaps rather sanguivorous insects, living on the blood of other animals. Their eggs are all nits. The Scorpio genus abound in hot climates, and are troublesome in neglected places, and where cleanliness is not attended to. The crab tribes cast their shells every year, and are then in a soft, helpless state, unable to make resistance, and therefore at that time become the prey of many kinds of fish, when not provided with a guardian. It is a remarkable fact, that the edible crab of the United States, when in this state of imbecility, places itself, for security, under the protection of one of its own species whose shell is hard and firm. This confidence is never misplaced; his protector defends him against every assault at the risk of his own life or limbs; and even when taken in the net, and thrown on shore, is still firmly held by his faithful companion. Their shells, but more especially those of the class testacea, afford a principal constituent in the formation of chalk-beds, and beds of marl, which are formed at the bottom of the sea. Specimens of entire shells are frequently met with in chalk-pits which are now many miles inland; and there is little doubt, that in a comminuted state they form a principal ingredient in most calcareous earth. Under each genus will be found an account of a few of the more remarkable species. See ACARUS, ARANEA, CANCER, SCORPIO, &c.

APUS, in astronomy, a constellation of the southern hemisphere, placed near the pole, between the Triangulum Australe and the Chameleon, supposed to represent the bird of paradise. There are four stars of the sixth, three of the fifth, and four of the fourth magnitude, in the constellation Apus. Dr. Halley, in 1677, ob-

served the longitude and latitude of the stars in Apus, which Hevelius in his prodromus reduced with some alteration to the year 1700. P. Noel has also given the places of these stars, with their right ascensions and declinations for the year 1687, but his observations differ widely from those of Dr. Halley. Hevelius has represented the figure of Apus, and its stars, in his Firmamentum Sobiescianum, according to Halley's account; Noel has done the like, according to his own account. Wolfius, with what justice we will not pretend to say, gives the preference to this last.

AQUA *fortis*. Another name for NITRIC ACID, which see. This name is applied to denote the common nitric acid used by workmen, which often contains a slight portion of muriatic acid. See CHEMISTRY.

AQUA *regia*, another name for the nitro muriatic acid. See MURIATIC ACID.

AQUÆDUCT, *a conduit of water*, in architecture and hydraulics, is a construction of stone or timber, built on an uneven ground, to preserve the level of water, and convey it, by a canal, from one place to another. Some of these aquæducts are visible, and others subterraneous. Those of the former sort are constructed at a great height, across vallies and marshes, and supported by piers and ranges of arches. The latter are formed by piercing the mountains, and constructing them below the surface of the earth. They are built of stone, brick, &c. and covered above with vaulted roofs or flat stones, serving to shelter the water from the sun and rain. Of these aquæducts, some are double, and others triple; that is, supported on two or three ranges of arches. Of the latter kind are the Pout-du-gard, in Languedoc, supposed to have been built by the Romans to carry water to the city of Nismes; that of Constantinople, and that which, according to Procopius, was constructed by Cosroes, King of Persia, near Petra, in Mingrelia, and which had three conduits in the same direction, each elevated above the other. Some of these aquæducts were paved, and others conveyed the water through a natural channel of clay: and it was frequently conducted by pipes of lead into reservoirs of the same metal, or into troughs of hewn stone. Aquæducts of every kind were reckoned among the wonders of ancient Rome; their great number, and the immense expense of bringing water 30, 40, or 60, and even 100 miles, either upon continued arches, or by means of other works, when it was necessary to penetrate mountains and rocks, may well astonish us. If we consider the incredible quantity of water brought to Rome for the uses of the public, for fountains, baths, fish-ponds, private houses, gardens and country-seats; if we represent to ourselves the arches constructed at a great expense, and carried on through a long distance, mountains levelled, rocks cut through, and vallies filled up, it must be acknowledged that there is nothing in the whole world more wonderful. For 440 years, the Romans contented themselves with the waters of the Tiber, and of the wells and fountains in the city and its neighbourhood. But when the number of houses and inhabitants was considerably augmented, they were obliged to bring water from remote places by means of aquæducts. Even Tiberius, Claudius, Caligula, and Caraccalla, though in other respects not of the best character, took care of the city in this useful article. There are still to be seen in the country about Rome wonderful remains of the ancient aquæducts, some elevated above the ground by arches continued and raised one above the other, and others subterraneous, passing through rocks; such is that seen at Vicovaro, beyond Tivoli, in which a canal pierces a rock to the extent of more than a mile, and about five feet deep and four broad. At certain distances vents were provided, so that the water which was accidentally obstructed in its passage, might be discharged till its ordinary passage was cleared; and in the canal of the aquæduct itself there were cavities, into which the water was precipitated, and where it remained till its mud was deposited; and ponds, in which it might purify itself. In the construction of these aquæducts, there was a considerable variety: that called the Aqua Martia had an arch of sixteen feet in diameter; it was constructed of three kinds of stone, and was formed with two canals, one above the other. The most elevated was supplied by the waters of the Tiverone, and Anionovus; the lowest by the Claudian water. The entire edifice was 70 Roman feet high. The arch of the aquæduct, which brought to Rome the Claudian water, was constructed of beautiful hewn stone. This is represented by Pliny as the most beautiful of all that had been built for the use of Rome. It conveyed the water through a vaulted canal, through the distance of 40 miles, and was so high, that it supplied all the hills of the city. According to him, and the computation of Budæus, the charge of this work amounted to 1,385,500 crowns.

This aquæduct was begun by Caligula, and finished by Claudius, who brought its waters from two springs, called Cæruleus and Curtius. Vespasian, Titus, Marcus Aurelius, and Antoninus Pius, repaired and extended it: it is now called Aqua Felice. The three chief aquæducts now in being are those of the Aqua Virginea, Aqua Felice, and Aqua Paulina. The first was repaired by Pope Paul IV. The second was constructed by Pope Sixtus V. and is called from the name which he assumed before he was exalted to the Papal throne. It proceeds from Palæstrina at the distance of twenty-two miles, and discharges itself at the Fontana di Termini, which was also built at his expense, and consists of three arches, supported by four Corinthian pillars, and the water gushes out through three large apertures. Over the middle arch stands a beautiful statue of Moses striking the rock with his rod; over another arch is a basso-relievo of Aaron leading the people to the miraculous springs in the wilderness, and the third exhibits Gideon trying his soldiers by their drinking water. Round it are four lions, two of marble, and the other two of oriental granite, said to be brought thither from a temple of Serapis. All the four lions eject water; and on the front is an inscription, importing that this aquæduct was begun in the first and completed in the third year of the pontificate of Sixtus V. 1588. The third was repaired by Pope Paul V. in the year 1612. This divides itself into two principal channels, one of which supplies Mount Janiculus, and the other the Vatican and its neighbourhood. It is conveyed through the distance of thirty miles, from the district of Bracciano, and three of its five streams are not inferior to small rivers, and sufficient to turn a mill. The famous aquæducts of Constantinople, about six miles from the village of Belgrade, were built by Valentinian the First, Clearchus being præfect, and afterwards repaired by Solyman the Magnificent, who exempted twelve adjacent Greek villages from the customary tribute of the empire, in consideration of their keeping these aquæducts in repair. Of these the most remarkable are three large and lofty fabrics, built over so many vallies betwixt the adjoining hills, of which the longest has many but less arches, and may possibly be the entire work of Solyman. The other two have the appearance of a more ancient and regular architecture, consisting of two rows of arches one over the other; and those of the second were enclosed by pillars cut through the middle, so as to render the fabric both passable like a bridge, and useful for the conveyance of water. The more considerable of these two consists of only four large arches, each twenty yards long, and somewhat above twenty high, supported by octangular pillars of about 56 yards in circumference towards the bottom. For an inquiry into the nature and construction of the aquæducts of the Romans, see Governor Pownal's Notices and Descriptions of Antiquities of the Provincia Romana of Gaul, 4to. 1788. The aquæduct built by Lewis XIV. near Maintinon, for carrying the River Bure to Versailles, is perhaps the greatest now in the world. It is 7000 fathoms long, and its elevation 2560 fathoms; containing 242 arcades.

AQUARIUS, in astronomy, a constellation which makes the eleventh sign in the zodiac, marked thus, ♒. It consists of 45 stars in Ptolemy's catalogue, of 41 in Tycho's, and in the Britannic catalogue of 108. It was called Aquarius, or the Water-bearer, as some say, because, during the sun's motion through this sign, it is generally rainy weather.

AQUARTIA, in botany, a genus of the Tetrandria Monogynia class and order. Calyx campanulate; corol. wheel-shaped, with linear segments; berry many-seeded. There are two species.

AQUATIC, in natural history, an appellation given to such things as live or grow in the water: thus we say, aquatic animals, aquatic plants, &c.

AQUEOUS *humour*, or the watery humour of the eye; it is the first and outermost, and that which is less dense than either the vitreous or crystalline. It is transparent and colourless like water, and fills up the space that lies between the cornea and the crystalline humour. See Optics.

AQUILA, the *eagle*, in ornithology. See Falco.

Aquila, in astronomy, a constellation of the northern hemisphere, consisting of 15 stars in Ptolemy's catalogue, 19 in Tycho Brahe's, 42 in that of Hevelius, and 71 in Flamstead's; the principal star being Lucida Aquila, and is between the first and second magnitude.

AQUILARIA, in botany, a large tree, affecting a lofty situation. Class Decandria Monogynia; cal. perianth one-leafed, permanent; tube bell-shaped; limb five-cleft; clefts ovate, acute, flat, spreading; cor. none: nectary one-leafed, pitcher-shaped, of the length of the tube of the calyx, half five-cleft; clefts bifid, obtuse;

stam. filaments ten, alternating with the clefts of the nectary; anthers oblong, versatile; pist. germ ovate, superior; style, none; stigma, simple; per. capsule on a very short pedicle, obovate, woody, two-celled, two valved, with the partition contrary, and bipartite; seeds solitary, oblong. There is but one species. Aquilaria ovata; leaves alternate, ovate mucronate. This is a large tree covered with greyish bark. Its leaves are entire, smooth, veined, about eight inches long, and stand on short hairy foot-stalks. The flowers terminate the branches, on many-flowered peduncles. A native of the mountains of Malacca and Cochin-China. The wood of this tree has been long used as a perfume; and was formerly an article of the materia medica under the name of agallochum, lignum aloes, or aloes wood. This wood in its natural state is white and inodorous. That which possesses the peculiar aroma, for which it is valued, is supposed to be the consequence of a diseased process in the tree, causing the oleaginous particles to stagnate and concrete into a resin in the inner parts of the trunk and branches, by which the natural appearance of the wood is altered, so as to become of a darker colour and of a fragrant smell. At length the tree dies, and, when splitten, the resinous part is taken out. The perfumes which this wood affords are highly esteemed by the oriental nations; and from the bark of the tree is made the common paper which the Cochin-Chinese use for writing; in the same manner the Japanese make use of the bark of a species of mulberry (morus papyrifera). This perfume is said to be useful in vertigo and palsy: given in the form of powder, it is recommended to restrain vomitings and alvine fluxes. To us, however, it seems to contain little else than that camphoraceous matter common to many other vegetable substances. From its bitter taste it has the name of aloes, although no otherwise allied to it.

AQUILEGIA, *columbine*, in botany, a genus of the Polyandria Pentagynia class of plants, having no calyx; the corolla consists of five plane, patent, equal petals, of a lanceolate, ovate figure; the nectaria are five in number; they are equal, and stand alternately with the petals; the fruit consists of five straight, parallel, cylindric, accuminated capsules, each of which consists of a single valve. The seeds are numerous, oval, carinated, and adhere to the suture. There are five species.

ARA, in astronomy, a southern constellation, consisting of eight stars.

ARABIS, in botany, *wall-cross*, a genus of the Tetradinamia Siliquosa class of plants, the calyx of which is a deciduous perianthium, consisting of four ovato-oblong, acute, gibbous, concave leaves; the corolla consists of four oval, patent, cruciform petals; the fruit is a very long compressed pod, containing several roundish compressed seeds. There are twenty-one species.

ARACHIS, in botany, *ground-nut*, a genus of the Diadelphia Decandria class of plants, the flower of which is papilionaceous, and consists of three petals; and its fruit is an oblong unilocular pod, contracted in the middle, and containing two oblong, obtuse, and gibbous seeds. There is but one species, found in the Indies, a tree, stem herbaceous, hairy, procumbent. The branches trail on the ground, and the germ, after flowering, thrusts itself under ground, where the food is formed and ripened.

ARACHNOIDES, in zoology, a name given to those echini marini, or sea-hedgehogs, which are of a circular form, but variously indented at the edges. See ECHINUS.

ARALIA, *berry-bearing angelica*, in botany, a genus of the Pentandria Pentagynia class of plants, the flowers of which are collected into an umbel, of a globose figure, with a very small involucrum; the perianthium is very small, divided into five parts, and placed on the germen; the corolla consists of five, ovato-acute, sessile, reflex petals, the fruit is a roundish, coronated, striated berry; having five cells: the seeds are single, hard, and oblong. There are four divisions, *viz.* A. leaves entire; B. leaves lobed; C. leaves in finger-like divisions; D. leaves decompound, and more than decompound. In the first there are three species; in the second one; in the third two; and in the fourth four.

ARANEA, in natural history, the *spider*, a genus of insects of the order Aptera. Gen. char. legs eight; eyes eight, sometimes six; mouth furnished with two hooks, or holders; feelers two, jointed, the tips of which in the male distinguish the sex; abdomen terminated by papillæ, or teats, through which the insect draws the thread.

One of the largest of the European spiders is the Aranea diadema of Linnæus, which is extremely common in England, and is chiefly seen during the autumnal

season in gardens, &c. The body of this species, when full grown, is not much inferior in size to a small hazel nut: the abdomen is beautifully marked by a longitudinal series of round, or drop-shaped milk-white spots, crossed by others of similar appearance so as to represent, in some degree, the pattern of a small diadem. This spider, in the months of September and October, forms, in some convenient spot or shelter, a large, round, close, or thick web of yellow silk, in which it deposits its eggs, guarding the round web with a secondary one of a looser texture. The young are hatched in the ensuing May, the parent insects dying towards the close of autumn. The Aranea diadema, being one of the largest of the common spiders, serves to exemplify some of the principal characters of the genus in a clearer manner than most others. At the tip of the abdomen are placed five papillæ or teats, through which the insect draws its thread; and as each of these papillæ is furnished with a vast number of foramina or outlets, disposed over its whole surface, it follows, that what we commonly term a spider's thread, is in reality formed of a collection of a great many distinct ones, the animal possessing the power of drawing out more or fewer at pleasure; and if it should draw from all the foramina at once, the thread might consist of many hundred distinct filaments. The eyes, which are situated on the upper part or front of the thorax, are eight in number, placed at a small distance from each other, and having the appearance of the stemmata in the generality of insects. The fangs, or piercers, with which the animal wounds its prey, are strong, curved, sharp-pointed, and each furnished on the inside, near the tip, with a small oblong hole or slit, through which is evacuated a poisonous fluid into the wound made by the point itself, these organs operating in miniature on the same principle with the fangs in poisonous serpents. The feet are of a highly curious structure; the two claws with which each is terminated being furnished on its under side with several parallel processes, resembling the teeth of a comb, and enabling the animal to dispose and manage with the utmost facility the disposition of the threads in its web, &c.

Aranea tarantula, or Tarantula spider, of which so many idle recitals have been detailed in the works of the learned, and which, even to this day, continues in some countries to exercise the faith and ignorance of the vulgar, is a native of the warmer parts of Italy, and other warm European regions, and is generally found in dry and sunny plains. It is the largest of all the European spiders, but the extraordinary symptoms supposed to ensue from the bite of this insect, as well as their supposed cure by the power of music alone, are entirely fabulous, and are now sufficiently exploded among all rational philosophers. The gigantic Aranea avicularia, or Bird-catching spider, is not uncommon in many parts of the East Indies and South America, where it resides among trees, frequently seizing on small birds, which it destroys by wounding with its fangs, and afterwards sucking their blood. During the early part of the last century, a project was entertained by a French gentleman, Monsieur Bon, of Montpelier, of instituting a manufacture of spiders' silk, and the royal Academy, to which the scheme was proposed, appointed the ingenious Reaumur to repeat the experiments of Monsieur Bon, in order to ascertain how far the proposed plan might be carried; but, after making the proper trials, Mr. Reaumur found it to be impracticable, on account of the natural disposition of these animals, which is such as will by no means admit of their living peaceably together in large numbers. Mr. Reaumur also computed that 663,522 spiders would scarcely furnish a single pound of silk. Monsieur Bon, however, the first projector, carried his experiments so far as to obtain two or three pair of stockings and gloves of this silk; which were of an elegant grey colour, and were presented as samples, to the Royal Academy. It must be observed, that in this manufacture it is the silk of the egg-bags alone that can be used, being far stronger than that of the webs. Monsieur Bon collected twelve or thirteen ounces of these, and having caused them to be well cleared of dust, by properly beating with sticks, he washed them perfectly clean in warm water. After this they were laid to steep, in a large vessel, with soap, saltpetre, and gum arabic. The whole was left to boil over a gentle fire for three hours, and were afterwards again washed to get out the soap; then laid to dry for some days, after which they were carded, but with much smaller cards than ordinary. The silk is easily spun into a fine and strong thread: the difficulty being only to collect the silk-bags in sufficient quantity. There remains one more particularity in the history of spiders, *viz.* the power of flight. It is principally in the autumnal season that

these diminutive adventurers ascend the air, and contribute to fill it with that infinity of floating cobwebs which are so peculiarly conspicuous at that period of the year. When inclined to make these aerial excursions, the spider ascends some slight eminence, as the top of a wall, or the branch of a tree; and turning itself with its head towards the wind, ejaculates several threads, and rising from its station, commits itself to the gale, and is thus carried far beyond the height of the loftiest towers, and enjoys the pleasure of a clearer atmosphere. During their flight it is probable that spiders employ themselves in catching such minute winged insects as may happen to occur in their progress; and when satisfied with their journey and their prey, they suffer themselves to fall, by contracting their limbs, and gradually disengaging themselves from the thread which supports them. See Plate I. Entomology, fig. 7 and 8.

ARAUCARIA, in botany, a genus of the Dioecia Monadelphia class and order. Male, calyx scales of an ament, terminated by a leaflet; no corol.; antheræ 10 to 12, without filaments. Female, calyx, an ament with many germs; no corol.; stigma two-valved, unequal; seeds numerous, in a roundish cone.

ARBITER, in civil law, a judge nominated by the magistrate, or chosen voluntarily by two parties, in order to decide their differences according to law.

The civilians make this difference between arbiter and arbitrator; though both ground their power on the compromise of the parties, yet their liberty is different, for an arbiter is to judge according to the usages of the law, but the arbitrator is permitted to use his own discretion, and accommodate the difference in the manner that appears to him most just and equitable.

ARBITRATION, a power given by two or more contending parties to some person or persons to determine the dispute between them; if the two do not agree, it is usual to add, that another person be called as umpire, to whose sole judgment it is then referred. The submission to arbitration is the authority given by the parties in controversy to the arbitrators, to determine and end their grievances; and this being a contract or agreement, must not be strictly taken, but largely, according to the intent of the parties submitted. There are five things incident to an arbitration: 1. Matter of controversy. 2. Submission. 3. Parties to the submission. 4. Arbitrators. 5. Giving up the arbitration. Matters relating to a freehold, debts due on bond, and criminal offences, are not to be arbitrated.

ARBITRATOR, a private extraordinary judge, chosen by the mutual consent of parties, to determine controversies between them. Arbitrators are to award what is equal between both parties, and the performance must be lawful and possible. An action of debt may be brought for money adjudged to be paid by arbitrators.

ARBOR *Dianæ*. See CHEMISTRY.

ARBOR *vitæ*. See THUJA.

ARBOR, in mechanics, the principal part of a machine which serves to sustain the rest; also the axis or spindle on which a machine turns, as the arbor of a crane, windmill, &c.

ARBUTUS, the *strawberry-tree*, in botany, a genus of the Decandria Monogynia class of plants, the calyx of which is a very small, obtuse, permanent perianthium, divided into five segments; the corolla consists of a single oval petal, divided also into five segments; the fruit is a roundish berry, containing five cells, and small osseous seeds. There are ten species.

ARC *concentric*, is that which has the same centre with another arc.

ARC *diurnal*, that part of a circle described by a heavenly body between its rising and setting; as the nocturnal arc is that described between its setting and rising: both these together are always equal.

ARCS *equal*, those which contain the same number of degrees, and whose radii are equal.

ARCA, in natural history, a genus of worms of the order Testacea; animal a tethys; shell bivalve, equivalve; hinge with numerous sharp teeth, alternately inserted between each other. There are, according to Gmelin, 43 species; but they are separated into four divisions, *viz.* A. margin very entire, beaks recurved; B. margin entire, beaks inflected; C. margin crenate, beaks recurved; D. margin crenate, beaks inflected: of the latter we shall notice A. nucleus; shell obliquely ovate, smoothish, with a triangular hinge; inhabits European seas, and is sometimes found fossile, the size of a hazel nut, covered with an olivaceous skin, under which it is white, within silvery; shell unequally triangular, with very fine perpendicular striæ, crossed by a few arched transverse ones; depression behind the beak, heart-shaped.

Of the division C. is the A. antiquata, which occurs frequently on the coast of

the United States, and is in many places called *Bloody Clam;* when opened the included liquid has a dirty red appearance; shell obliquely heart-shaped, with numerous unarmed grooves; it is white, but covered with a brownish hairy skin: the anterior slope with a compressed prominent angle.

ARCH, or ARC, in geometry, any part of the circumference of a circle, or curved line, lying from one point to another, by which the quantity of the whole circle or line, or some other thing sought after, may be gathered.

All angles are measured by arcs. For this purpose an arc is described having its centre in the point or vertex of the angle: and as every circle is supposed to be divided into 360°, an arc is estimated according to the number of degrees which it contains. Thus an arc is said to be of 30, 50, or 100 degrees, &c.

ARCH, in architecture, a concave building, with a mould bent in the form of a curve, erected to support some structure. Arches are either circular, elliptical, or straight, as they are improperly called by workmen. Circular arches are also of three kinds: 1. Semicircular, which have their centre in the middle of a line drawn betwixt the feet of the arch. 2. Scheme or skene, which are less than a semicircle, containing some 90 and some 70 degrees. 3. Arches of the third and fourth point, consisting of two arches of a circle meeting in an angle at the top, being drawn from the division of a chord into three or more parts at pleasure.

Elliptical arches consist of a semi-ellipsis, and have commonly a key-stone and imposts: they are usually described by workmen on three centres.

Straight arches are those used over doors and windows, having plain straight edges, both upper and under, which are parallel, but both the ends and joints point towards a centre.

The term arch is peculiarly used for the space between two piers of a bridge, intended for the passage of water, vessels, &c.

ARCH *of equilibration*, is that which is in equilibrium in all its parts, having no tendency to break in any one part more than in another; and which is, therefore, safer and stronger than any other figure. No other arch than this can admit of a horizontal line at top: it is of a form both graceful and convenient, as it may be made higher or lower at pleasure, with the same span. All other arches require extrados that are curved, more or less, either upwards or downwards; of these, the elliptical arch approaches the nearest to that of equilibration for strength and convenience, and it is the best form for most bridges, as it can be made of any height to the same span, its haunches being at the same time sufficiently elevated above the water, even when it is very flat at top. Elliptical arches also appear bolder and lighter, are more uniformly strong, and are cheaper than most others, as they require less materials and labour. Of the other curves, the cycloidal arch is next in quality to the elliptical one, and lastly the circle.

ARCHANGEL, in botany. See LAMIUM.

ARCHES, or *Court of* ARCHES, the supreme court belonging to the Archbishop of Canterbury, to which appeals lie from all the inferior courts within his province.

ARCHETYPE, the first model of a work which is copied after, to make another like it. Among minters it is used for the standard weight by which the others are adjusted. The archetypal world, among Platonists, means the world as it existed in the idea of God, before the visible creation.

ARCHIL. See LICHEN.

ARCHIMEDES, in biography, one of the most celebrated mathematicians among the ancients, who flourished about 250 years before Christ, being about 50 years later than Euclid. He was born at Syracuse in Sicily, and was related to Hiero, who was then king of that city. The mathematical genius of Archimedes set him with such distinguished excellence in the view of the world, as rendered him both the honour of his own age, and the admiration of posterity. He was indeed the prince of the ancient mathematicians, being to them what Newton is to the moderns, to whom in his genius and character he bears a very near resemblance. He was frequently lost in a kind of reverie, so as to appear hardly sensible; he would study for days and nights together, neglecting his food; and Plutarch tells us that he used to be carried to the baths by force. Many particulars of his life, and works, mathematical and mechanical, are recorded by several of the ancients, as Polybius, Livy, Plutarch, Pappus, &c. He was equally skilled in all the sciences, astronomy, geometry, mechanics, hydrostatics, optics, &c. in all of which he excelled, and made many and great inventions.

Archimedes, it is said, made a sphere of glass, of a most surprising contrivance

and workmanship, exhibiting the motions of the heavenly bodies in a very pleasing manner.

Many wonderful stories are told of his discoveries, and of his very powerful and curious machines, &c. Hiero once admiring them, Archimedes replied, these effects are nothing, "but give me," said he, "some other place to fix a machine on, and I will move the earth." He fell upon a curious device for discovering the deceit which had been practised by a workman, employed by the said king Hiero to make a golden crown. Hiero, having a mind to make an offering to the gods of a golden crown, agreed for one of great value, and weighed out the gold to the artificer. After some time he brought the crown home, of the full weight; but it was afterwards discovered or suspected that a part of the gold had been stolen, and the like weight of silver substituted in its stead. Hiero, being angry at this imposition, desired Archimedes to take it into consideration, how such a fraud might be certainly discovered. While engaged in the solution of this difficulty, he happened to go into the bath; where observing that a quantity of water overflowed, equal to the bulk of his body, it presently occurred to him, that Hiero's question might be answered by a like method; upon which he leaped out, and ran homeward, crying out ευρηκα! ευρηκα! I have found it out! I have found it out! He then made two masses, each of the same weight as the crown, one of gold and the other of silver; this being done, he filled a vessel to the brim with water, and put the silver mass into it, upon which a quantity of water overflowed equal to the bulk of the mass; then taking the mass of silver out he filled up the vessel again, measuring the water exactly which he put in; this shewed him what measure of water answered to a certain quantity of silver. Then he tried the gold in like manner, and found that it caused a less quantity of water to overflow, the gold being less in bulk than the silver, though of the same weight. He then filled the vessel a third time, and putting in the crown itself, he found that it caused more water to overflow than the golden mass of the same weight, but less than the silver one; so that, finding its bulk between the two masses of gold and silver, and that in certain known proportions, he was able to compute the real quantities of gold and silver in the crown, and so manifestly discovered the fraud.

Archimedes also contrived many machines for useful and beneficial purposes: among these, engines for launching large ships; screw pumps, for exhausting the water out of ships, marshes or overflowed lands, as Egypt, &c. which they would do from any depth.

But he became most famous by his curious contrivances, by which the city of Syracuse was so long defended, when besieged by the Roman consul Marcellus; showering upon the enemy sometimes long darts and stones of vast weight and in great quantities; at other times lifting their ships up into the air, that had come near the walls, and dashing them to pieces by letting them fall down again: nor could they find their safety in removing out of the reach of his cranes and levers, for there he contrived to set fire to them with the rays of the sun reflected from burning glasses.

However, notwithstanding all his art, Syracuse was at length taken by storm, and Archimedes was so very intent upon some geometrical problem, that he neither heard the noise, nor regarded any thing else, till a soldier that found him tracing lines asked his name, and upon his request to begone, and not disorder his figures, slew him. "What gave Marcellus the greatest concern, says Plutarch, was the unhappy fate of Archimedes, who was at that time in his museum; and his mind, as well as his eyes, so fixed and intent upon some geometrical figures, that he neither heard the noise and hurry of the Romans, nor perceived the city to be taken. In the depth of study and contemplation, a soldier came suddenly upon him, and commanded him to follow him to Marcellus; which he refusing to do, till he had finished his problem, the soldier in a rage drew his sword, and ran him through." Livy says he was slain by a soldier, not knowing who he was, while he was drawing schemes in the dust; that Marcellus was grieved at his death, and took care of his funeral; and made his name a protection and honour to those who could claim a relationship to him. His death it seems happened about the 142d or 143d Olympiad, or 210 years before the birth of Christ.

When Cicero was quæstor for Sicily, he discovered the tomb of Archimedes, all overgrown with bushes and brambles; which he caused to be cleared, and the place set in order. There were a sphere and cylinder cut upon it, with an inscription, but the latter part of the verses were quite worn out.

Many of the works of this great man

are still extant, though the greatest parts of them are lost. The pieces remaining are as follow: 1. Two books on the Sphere and Cylinder.—2. The Dimension of the Circle, or Proportion between the Diameter and the Circumference.—3. Of Spiral lines.—4. Of Conoids and Spheroids.—5. Of Equiponderants, or Centres of Gravity.—6. The Quadrature of the Parabola.—7. Of Bodies floating on Fluids.—8. Lemmata.—9. Of the Number of the Sand.

Among the works of Archimedes which are lost may be reckoned the descriptions of the following inventions, which may be gathered from himself and other ancient authors. 1. His account of the Method which he employed to discover the Mixture of Gold and Silver in the crown mentioned by Vitruvius.—2. His Description of the Cochleon, or engine to draw water out of places where it is stagnated, still in use under the name of Archimedes's Screw. Athenæus, speaking of the prodigious ship built by the order of Hiero, says, that Archimedes invented the cochleon, by means of which the hold, notwithstanding its depth, could be drained by one man. And Diodorus Siculus says, that he contrived this machine to drain Egypt, and that, by a wonderful mechanism, it would exhaust the water from any depth. 3. The Helix, by means of which, Athenæus informs us, he launched Hiero's great ship.—4. The Trispaston, which, according to Tzetzes and Oribasius, could draw the most stupendous weights.—5. The Machines, which, according to Polybius, Livy, and Plutarch, he used in the defence of Syracuse against Marcellus, consisting of Tormenta, Balistæ, Catapults, Sagittarii, Scorpions, Cranes, &c.—6. His Burning Glasses, with which he set fire to the Roman gallies.—7. His Pneumatic and Hydrostatic Engines, concerning which subjects he wrote some books, according to Tzetzes, Pappus, and Turtullian.—8. His Sphere, which exhibited the celestial motions. And probably many others.

A considerable volume might be written upon the curious methods and invention of Archimedes, that appear in his mathematical writings now extant only. He was the first who squared a curvilineal space; unless Hipocrates be excepted on account of his lunes. In his time the conic sections were admitted into geometry, and he applied himself closely to the measuring of them, as well as other figures. Accordingly he determined the relations of spheres, spheroids, and conoids, to cylinders and cones; and the relations of parabolas to rectilineal planes, whose quadratures had long before been determined by Euclid. He has left us also his attempts upon the circle: he proved that a circle is equal to a right-angled triangle whose base is equal to the circumference, and its altitude equal to the radius; and consequently, that its area is equal to the rectangle of half the diameter and half the circumference; thus reducing the quadrature of the circle to the determination of the ratio between the diameter and circumference; which determination however has never yet been done. Being disappointed of the exact quadrature of the circle, for want of the rectification of its circumference, which all his methods would not effect, he proceeded to assign an useful approximation to it: this he effected by the numeral calculation of the perimeters of the inscribed and circumscribed polygons: from which calculation it appears that the perimeter of the circumscribed regular polygon of 192 sides is to the diameter in a less ratio than that of $3\frac{1}{7}$ or $3\frac{10}{70}$ to 1; and that the perimeter of the inscribed polygon of 96 sides is to the diameter in a greater ratio than that of $3\frac{10}{71}$ to 1; and consequently that the ratio of the circumference to the diameter lies between these two ratios. Now the first ratio, of $3\frac{1}{7}$ to 1, reduced to whole numbers, gives that of 22 to 7, for $3\frac{1}{7} : 1 :: 22 : 7$; which therefore is nearly the ratio of the circumference to the diameter. From this ratio between the circumference and the diameter, Archimedes computed the approximate area of the circle, and he found that it is to the square of the diameter as 11 is to 14. He determined also the relation between the circle and eclipse with that of their similar parts. And it it probable that he likewise attempted the hyperbola; but it is not to be expected that he met with any success, since approximations to its area are all that can be given by the various methods that have since been invented.

Besides these figures, he determined the measures of the spiral, described by a point moving uniformly along a right line, the line at the same time revolving with a uniform angular motion; determining the proportion of its area to that of the circumscribed circle, as also the proportion of their sectors.

Throughout the whole works of this great man, we every where perceive the deepest design, and the finest invention. He seems to have been, with Euclid, exceedingly careful of admitting into his demonstrations nothing but principles perfectly geometrical and unexceptionable:

and although his most general method of demonstrating the relations of curved figures to straight ones, be by inscribing polygons [illegible] those relations, he does not increase the number, and diminish the magnitude, of the sides of the polygon *ad infinitum*; but from this plain fundamental principle, allowed in Euclid's Elements, (*viz.* that any quantity may be so often multiplied, or added to itself, as that the result shall exceed any proposed finite quantity of the same kind,) he proves, that to deny his figures to have the proposed relations would involve an absurdity. And when he demonstrated many geometrical properties, particularly in the parabola, by means of certain progressions of numbers, whose terms are similar to the inscribed figures; this was still done without considering such series as continued *ad infinitum*, and then collecting or summing up the terms of such infinite series.

There have been various editions of the existing writings of Archimedes. But the most complete of any is the magnificent edition, in folio, lately printed at the Clarendon press, Oxford, 1792. This edition was prepared ready for the press by the learned Joseph Torelli, of Verona, and in that state presented to the university of Oxford. The Latin translation is a new one. Torelli also wrote a preface, a commentary on some of the pieces, and notes on the whole. An account of the life and writings of Torelli is prefixed, by Clemens Sibiliati. And at the end a large appendix is added, in two parts; the first being a Commentary on Archimedes's paper upon Bodies that float on Fluids, by the Rev. Adam Robertson, of Christ Church College; and the latter is a large collection of various readings in the manuscript works of Archimedes, found in the library of the late King of France, and of another at Florence, as collated with the Basil edition above mentioned.

ARCHITECTURE.

General observations on the history and practice of Civil Architecture.

All the variety of edifices appropriated to the purposes of civil life is denominated Civil Architecture.

It is a very difficult matter for us at this day to trace the earliest stage of this art, so indispensible to our comfort and protection in a natural or civilized state, until we find its permanence of construction fixed on the basis of science and proportion.

The subterraneous cavern was without doubt the first habitation of man. Who cannot but contemplate with astonishment the variety of massy shapes, supporting arched roofs, decorated with innumerable surfaces of crystallized forms, excelling in splendour of design and arrangement the most magnificent productions of human art.

All our impressions of wisdom, strength and beauty, are derived from the examination of the works of the God of nature: All our energy in art is employed to deduce from these works the proximity of man to his Creator, and all our perfection a humble acknowledgment of our imperfection.

In sculpture and painting, the closest imitation of a model in nature at once constitutes the excellence of the artist.

In architecture, invention is employed in the search of form and proportion, that is not so immediately obvious, owing to the whimsicality in matters of taste, which is perhaps very justly regulated by antique proportion.

History furnishes us with very vague and unsatisfactory accounts of the rise or progress of this science; although a variety of speculation has been indulged, to locate and fix its origin and æra of construction in India and Egypt, we are at this late day left to doubt, whether the eastern quarter of the world has any decided claim to originality over that of Egypt.

The splendid excavations that constitute the temples or sacred edifices of the Hindoos, particularly the cave at Elephanta, which is sculptured out of the solid rock, exhibits a very early knowledge of the art with this barbarous people. The cave is 120 feet square, and contains four rows of massy pillars, resembling a fluted ballustrade, resting on a long right angular plinth; the whole pillar is surmounted by a broad projecting capital, in form of a flat vase, richly and highly decorated. Colossal statues and busts in alto relievo protrude from the sides of the cavern, some with four, and some with six arms, bearing sceptres, trophies, and symbols of their mythology. The

altar is situated in the centre of one of the sides, the entrance to which is guarded by two huge figures, bearing very little resemblance [illegible] of an octagonal shape are sometimes mounted on the backs of elephants, horses and tygers, supporting a cornice decorated with human figures sitting cross-legged. A gallery extends from pillar to pillar, profusely sculptured with men in acts of devotion to serpents, tygers, and other animals. The base of the columns being an elephant (their favourite beast) sometimes displays a man astride of the trunk, which gives the general mass the effect of being put in motion by these mighty animals.

The whole may be considered original, and peculiar to the habits of an uncivilized people, intuitively representing natural objects of their religious devotion, in crude, disproportioned sculpture.

From the magnificent ruins of Persepolis in Persia, which, according to Le Brun, originally consisted of 205 columns, 70 feet in height, we are alone enabled to give any account of the ancient style of architecture in that country; for the character and remains of this interesting palace, the world is indebted to the able research of this gentleman, who has left no stone unturned that could elucidate, or bring to light, a knowledge of the science at that early day.

The arrangement, construction, and proportions of Persepolis differ very materially from the Indian or Egyptian style of building, yet we find Egyptian doorways at its entrance, and Indian sculptured excavation in the tomb of Darius.

The Persians held Egyptian mythology in detestation, and it appears were not devoted to the erection of sacred edifices, as no remnant of a religious symbol, or hieroglyphic, is to be found in their ruins; but, on the contrary, they appear to have been wholly absorbed in the erection of gorgeous palaces and tombs.

Their sculptures are very numerous, and consist of triumphal processions, offerings of horses to the sun, and oxen to the moon; figures bearing the parasol, and armed with the lance, in conflict with the lion. The number of men and animals found on their tombs are nearly thirteen hundred. Their columns have no diminish, being uniform from top to bottom, and thirteen diameters in height, having a capital one-fourth their height, carved in imitation of feathers tied or banded with silk; being the materials with which eastern monarchs formed their most splendid decorations. From the slender make of these columns, and no fragments of a cornice or roof being found [illegible] that Persepolis was a summer residence, and that they supported a temporary covering, slightly constructed of wood, and lined with silken drapery.

These ruins bear incontrovertible evidence of antiquity, with features distinctly marked to characterise a separate school of architecture. The devastation which followed the conquest of Egypt by Cambyses, whose jealousy of the perfection of the Egyptians in art and science caused him to prostrate their palaces and temples, carrying off the artists as well as the spoils to grace this palace, accounts very satisfactorily for the mixture of Egyptian with Persepolitan ruins.

The whole of Upper Egypt furnishes prodigies in science and art. Their pyramids, palaces, temples, and excavated sepulchres. Their system of hieroglyphical sculpture is calculated to impress us with a very elevated idea of that once learned and powerful people; who, notwithstanding the inroads of frequent conquerors, jealous of their acquirements, and laying waste their works of art, rose, Phœnix like, from her ashes, invigorated by persecution.

The pyramids of Cheops, Cephren, and Mycerines, are alone sufficient to call forth the attention of mankind, as stupendous monuments of industry and imperishability. Although history can give us no satisfactory date of their construction, many learned men have discussed their antiquity, and concluded that Cheops, which is the largest, (being 448 feet in height and 728 feet square at the base) was erected 490 years before the first Olympiad, or about 3000 years ago.

The researches of Denon, and the French commission of arts, are the best authorities that can be quoted on the subject of Egyptian architecture: they have examined with zeal and accuracy each well collected fragment, under the protection of an armed force: we will therefrom proceed in giving a general outline of its particular character in Upper Egypt.

On approaching the edifices of Karnac and Luxor, the first grand masses of buildings are the moles, of an oblong plan, with battering or tapering sides, from 50 to 60 feet in height, decorated on their facade profusely with hieroglyphics, in the front of which stand the obelisks, on each side of the principal entrance, also crowded with symbols of mythology,

astronomy, history and agriculture. The tapering moles are crowned by a cavetto or flat segment of a circle, richly fluted torus that covers the corners of the pile. The entrance or door-way is between the moles, and is surmounted by a similar cavetto over the architrave, upon which is frequently carved the globe, wings, and serpent. This entrance opens into a grand court, surrounded on all sides by a portico, consisting of two ranges of columns, 48 in number; at the extremity of this court, and opposite the entrance, the sanctuary is placed, and contains apartments for the priests—two small porticos or covered ways conduct to those of the kings, and are distinguished by doors of black granite. Other avenues lead to buildings of considerable magnitude, ornamented with rows or alleys of lions, sphinxes and rams, from 15 to 16 feet in length, couchant upon pedestals ten feet asunder.

Some of their sculpture is merely a deep cut outline, and is no doubt the first dawning of the art. Basso relievo, semi relief, and alto relief, is every where to be seen, producing bold and decisive effects.

Although a perfect uniformity exists in all the edifices of Upper Egypt as to plan and general arrangement, it appears they were very capricious in the proportions and sculpture of columns. The capitals of the columns of the temple of Appolinipolis, one of the largest and most magnificent buildings in Egypt, has two rows of leaves, bearing considerable resemblance to the Corinthian of the Greeks. At the tombs of Silsilis, the columns are in imitation of bundles of reeds bound together at the top by a cord, and gradually swelling into a capital, ornamented with leaves and blossoms of the lotus, or lily of the Nile. At Tentyra, one entire column of hieroglyphics supports a capital, containing four heads of the goddess Isis. At the Memnonium, human figures are used as columns, called by the Greeks cariatides, at which place the ruins of a statue 64 feet in height is to be seen, and supposed to have been thrown down by Cambyses.

Their edifices and statuary is principally composed of granite and sand stone quarried upon the Nile, with aqueducts leading from them into the river, through which means, and its annual rise, the huge masses of stone used in obelisks and columns were floated to their respective situations; but how these immense slabs and blocks were raised upon terraces and columns, of great height, is an exertion of the mechanic powers totally obsolete at the present day.

It is only from the indestructible re- [illegible] architecture of Egypt, that we are enabled to form any distinct idea of the progress of science with this learned people; who are said to have invented geometry, and applied its principles to the motion of the heavenly bodies. At Tentyra, the great circle of the sphere is described upon the ceiling of the temple, containing the twelve signs of the zodiac, with many other astronomical figures in the surrounding spaces.

Their knowledge of geometry, and the application of its principles to mechanics, was astonishing, from the size and weight of their materials, and principles of construction, by which they have ensured durability; and transmitted to postority 5 palaces and 34 temples, as monuments of their science and industry 3000 years ago.

Upon an examination of the principles and practice of the architecture of the three countries, India, Persia, and Egypt, it will appear, upon investigation, that the edifices of Hindostan consist principally of excavation, where the column and human figure are rudely carved, without reference to proportion or the nature of the subject, and although we cannot fail to be disgusted with the effect of the performance, we are compelled to admire their industry. The resemblance of many leading features of Hindoo architecture to that of Egypt and Persia, particularly those of Elephanta and Vellore, has induced Sir William Jones and Dr. Robertson to conclude that the eastern quarter of the world has a preferable claim to originality; and that all rudiments of knowledge in the science was furnished by India to both the other countries: this is a mere matter of opinion, and can only amount to evidence of an early intercourse or communication of architectural knowledge, as there is unquestionably sufficient distinction in the character and proportions of the whole or parts to form separate schools. That of India may be characterized by circular outlines resembling the pagoda of the Chinese. The ancient Persian, consisting principally of edifices above ground with slender columns of small diameter, lightly and delicately decorated with feathers and silk, ornamental pannels in basso relievo, resembling the sumptuous corinthian of the Romans.

That of Egypt, grand and massy features, diminishing from the base upward, forming pyramidal figures, remarkable

for sameness of character and proportion. Temples generally peripteral, that is, surrounded on all sides by columns at some distance from the cell, decorated with the Lotus, Hawk, and Ibis, being favourite emblems, and purely their own. Upon the whole, we may conclude that the Egyptians borrowed no ideas, nor copied the style or practice of any other nation. A perfect uniformity in their sculpture and facade is seen every where, from the most ancient down to the destructive inroad of Cambyses.

Before we proceed to point out the character and sublimity of Greek architecture, it will be necessary to give a few general ideas as to the principles of the science, and upon what *Order* is founded.

All the variety of objects that present themselves to our view in the material world, are considered beautiful or deformed, in relation to their shape and size, corresponding with the fitness of the parts to the end designed. Proportion and symmetry always convey pleasureable ideas; and their adaptation to the expression of design should always coincide with the uses of the object in view. Skill and dexterity may be expressed, without accommodation or correspondence to the nature of the character, and must be admired as a part, without any reference to the whole: thus a building may be crowded with highly decorated mouldings and pannel-work, where the nature of the subject is not consulted, and by many unacquainted with the science be pronounced *beautiful*, receiving the appellation from a close examination of a particular part, when the fitness or proper correspondence of the minutiæ ought to be judged of with reference to the nature of the subject.

Therefore the sensations of pleasure that are felt, from the observance of an object well proportioned, must owe their existence to the proper distribution of all the parts combined in unison, to the expression of a decided character. Objects that are destitute of natural beauty are made so when regarded in the light of their uses.

The orders of architecture, in which all the variety of genius and art has evolved itself, and which is regulated by settled proportion, with such certainty as to defy and mock all attempts at innovation, receive their sanction from the above remarks on the observance of design accommodating itself to uses; whereby beauty and harmony is established.

There are five orders in architecture, viz, the Tuscan, Doric, Ionic, Corinthian, and Composite. These are, properly speaking, but three, the Doric, Ionic, and Corinthian, being originally invented by the Greeks. Proportion constitutes an *Order*, and consists of three grand divisions, viz. the base, column, and entablature. These are governing principles; and the proportions of the base and shaft are such, according to the character of the order, as appear, and are absolutely adequate to the support of the entablature which rests upon them. The great object derived from the difference or variety of the orders is, the fitness of their respective parts to the support of the crowning weight, which must appear evident to all who have paid the least attention to the subject.

It is rather astonishing from what cause we feel pleasant sensations upon viewing the Greek structures, whether it is the nature of the architecture itself that imparts pleasurable ideas, or the associations connected with them, that calls forth our admiration, knowing them to be reared upon classic ground, and the relics of a brave and enlightened people; but certain it is, their *science, skill,* and *taste* in the arts, far surpassed all other nations before and since their time.

This singular and industrious people, untrammelled with tyranny, situated in a rugged country, of fine climate, and abounding with forests, gave full scope to their imagination in the construction of wooden edifices; in the prosecution of which, the rude forest tree, covered with a block or tile, suggested the idea of the Doric order; the beams laid horizontally on the top, and projecting over the trunk of the tree, and rafters rising to a point in the centre, composed the leading features of a primitive Greek edifice.

It has been supposed that the Greeks were originally colonies of Egypt and Persia, at the time when those empires existed in great splendour, and constructed edifices of great magnificence; being also the countries from whence their sages drew their earliest information, rendered it more than probable that they borrowed their first ideas of building from those places; they unquestionably were acquainted with the state of architecture in those countries; but that they adopted or applied this information is very doubtful, from the circumstance of their materials, in the first instance, being altogether wood, and consequently requiring different principles and practice in its execution and arrangement. Stone edifices

were afterwards constructed in conformity with the wooden model, and underwent, at different periods of time, such additional arrangement as their genius and taste suggested.

The Greeks, untaught by their more rich neighbours, abounding in granite, porphyry, and marble, with a variety of other local advantages, established a perfect school of architecture, by the invention of three complete orders, each having a peculiar and separate character, calculated for all kinds of structures, ascending from the most simple and robust, to those of a more delicate susceptibility of ornament; completing a perfect system in the art, that defies all human attempts to surpass or amend.

The most magnificent temple at Athens, and one which exhibits the perfection of Greek taste, is that dedicated to Minerva Parthenon. It is situated on the summit of the rock of the citadel, within the Acropolis, which appears as though nature had formed it as a pedestal, expressly for the purpose of supporting the beautiful edifices upon its crown. It was executed under the direction of Phidias, by Callicrates and Ictinus; and from the description of Mr. Stuart, who spent seven years in the faithful delineation of the works of art in that once splendid city, is a perfect specimen of the Doric order. Its extreme length is 225 feet, and breadth 100 feet, surrounded by 46 columns, supporting an entablature of 12 feet in height, upon which is sculptured, in the finest alto relievo, the wars between the Lapithæ and the Centaurs. The frize which surrounds the cell contains the Panathenaic procession of Charioteers, horsemen, and the coronation of a youthful victor in the chariot races. On the eastern pediment is represented a convention of the gods, consisting of five and twenty figures: Jupiter presides, and is in the act of receiving his daughter Minerva.

The blocks of stone with which the columns are formed, being six feet in diameter, are so nicely and accurately wrought, that the most strict scrutiny is required to discover the joints, being no thicker than the finest hair. In order to attain this perfection, the marble is reduced to the proper size by the chisel, after which two pieces are rubbed one upon the other, with sand and water placed between them as a cutting medium, until the top and bottom beds come so closely in contact, as to exclude the atmosphere, and bed themselves together. After which process, they were regulated by a square pivot of olive wood with astonishing accuracy; so much so, as to give the whole pillar the effect of having passed through a lathe.

Chauteaubriand, seated on a fragment at the summit of the Acropolis, describes the ruins of the Parthenon with all the enthusiasm of a poet and artist: "From the summit of the Acropolis, I beheld the sun rise between the two peaks of mount Hymettus. The crows, which build their nests around the citadel, but never soar to its summit, hovered below us; their black and polished wings were tinged with roseate hues by the first radiant beams of Aurora. Columns of light blue smoke ascended in the shade along the sides of the Hymettus. Athens, the Acropolis, and the ruins of the Parthenon, were coloured with the most beautiful tints of peach blossom. The sculptures of Phidias, struck horizontally by a ray of gold, started into life, and seemed to move upon the marble, from the mobility of the shadows of relief."

Athens abounds with numerous and prodigious relices of the works of art. Adjacent to the Parthenon stands the temple of Neptune and Minerva Polias, the temples of Theseus, Propylea, and Jupiter Olympus, which was composed of 128 columns, sixty feet in height; the distance round this temple is said to be half a mile. The walls of the city extended over a space of nine leagues, and broad enough to admit of two chariots to run abreast, being equal to the huge fortified walls of the Romans.

Many of these masterpieces of antiquity, which excite the veneration of the modern world, 120 years ago were perfect, and had suffered but little dilapidation from the attacks of time, until some penetrative and investigating travellers paid them a visit, more from curiosity than information, and, not unlike children with a new toy, broke off the *pretty* parts, in order to discover how it was made, and, like Ulysses with his presents from the Phœnicians, return home with large chests full of stones, to enrich museums, and tickle connoisseurs.

The most daring outrage of this kind was committed by Lord Elgin, who employed the Turks to break off, and throw down part of the frize and pediment of the Parthenon. His sole object in bearing off the works of Phidias was, merely to show the British nation the wonderful degree of perfection the Greeks had arrived to in the art of sculpture; and, as a further extenuation of his conduct, to

preserve them unimpaired by the hand of ignorant barbarism, so peculiar to Musselmen and Frenchmen: for which his zeal and judgment, in literally robbing a church, has received the warmest acknowledgments of the British artists, who still suffer him to keep an Italian mercenary in Greece, destroying and pilfering what is termed the "Elgin Marbles."

Such inconsiderate love of the arts, contrasted with the laudable exertions of the scientific Stuart, is truly disgusting. This ingenious traveller was indefatigable in drawing, measuring, and accurately describing these interesting works of antiquity, and devoted seven years in the accomplishment of a work that does honour to the British arts, by transmitting to posterity the genius and taste of the Greeks, under the influence of Pericles and Adrian; in the perusal of whose pages we may exclaim, "There was a time, when Greece, when Athens, existed: now neither is there an Athens in Greece, nor is Greece *itself* any longer to be found." And when we search for architecture, we may find it buried in its own ruins.

The Romans were humble copiers of Greek Architecture in every thing but its simplicity; they laboured in complicated forms, and dressed out the chaste orders into unmeaning frivolities. Columns were coupled, and piled on columns, enormous basements were erected on the tops of Porticoes, crushing all beneath with the superincumbent weight, plane surfaces were intersected with fluted pilasters, and the intermediate space filled up, and enriched with tablets of festoons, and perforated with stories of small windows.

The Romans acquired all their knowledge of the arts by the prowess of their arms; and, not possessing any native taste, acquired by the unremitting attempts of rival artists, they could not be supposed to select the most chaste features, but eagerly seized upon the Corinthian, being the most sumptuous of the Greek orders, and applied it in their public buildings, almost to the total exclusion of all others, inventing an order still more rich and profuse, called the Composite, which is compounded of the Corinthian leaves, surmounted by the Ionic Echinus and Volutes.

The edifices erected during the republican state of the country are known by their simplicity and usefulness, while those of the emperors are remarkable for ornament. The emperor Adrian journeyed over all his provinces, building and restoring cities and public edifices. At Athens he built the immense Temple of Jupiter Olympus, repaired the gates of the city, which by inscription he claimed as his own. He built the aqueducts that supplied the city of Corinth with water, and the great wall across the Island of Great Britain, from New-Castle to Carlisle.

The emperor Augustus said he found Rome composed of brick, but he had changed it into marble. Among the numerous edifices constructed during his reign were, the Temple and Forum of Mars the avenger; Jupiter Tonans in the capital pantheon, dedicated to all the gods; and a temple to Minerva composed entirely of brass; and he brought the Aqua Virginis to Rome through an aqueduct 14 miles in length.

Dioclesian reared the stately corinthian in the ancient city of Tedmor in the wilderness, built by Solomon, and called by the Romans Palmyra.

Throughout the Roman dominions the Corinthian was the prevailing order. The Ionic appears to have been the favourite order in Asia Minor; the Corinthian in the colonies of Rome; and the sober Doric every where the most ancient and lasting of them all.

At Palmyra and Balbec their rectangular temples are very extraordinary in point of extent; and the superb style of decoration to which their arts were carried—the immense size of the materials in the temple at Balbec; is perhaps greater than any employed in Egypt. In the quarry without the walls of the city lies a stone 70 feet in length, and 14 feet square, in the shape of a parallelopipedon, containing 14,128 cubic feet, and weighing upwards of 1130 tons.

Although the Romans can claim but little merit of originality in what relates to civil architecture, the modern world is very much indebted to them for a very important feature in the science of building: that is, the invention of the arch, which was entirely unknown to the Greeks previous to the Roman conquest. The utility and grandeur of this important invention is fully demonstrated in the extensive vaults, domes, bridges, and aqueducts, with which their most superb edifices were constructed and adorned, the judicious arrangement of which never fails to produce the most pleasing effects, particularly when constructed on an extended span.

The profuse introduction of arches in the facades of edifices generally destroys the effect of other features, composed of

straight lines. The Romans became so enamoured with them, as to spring them from the base capital of a column, which is intended solely for perpendicular support, and not to counteract lateral pressure. From one absurdity to another more gross, their original purity became almost extinct. The orders, which had already become overloaded with ornament, were scarcely able to support the unmeaning trappings with which they were disguised, and their ingenuity, being almost without bounds, discovered and added traits to their character not much unlike the Gothic. This anarchy in the state of architecture was happily relieved by an interregnum of the Gothic style, which branched forth its delicate limbs and beautiful tracery. A short time previous to the incursions of the Goths and Huns, a decidedly new character appeared in the art. The basilicæ of all the great cities of the empire were converted into christian churches, keeping up the same form of rectangular parallelograms, dividing the cell into aisles by two rows of columns, with arches springing from their capitals to support the roof; wings were added to the flanks of these buildings, forming on the ground plan the Latin cross, which has continued to be the model of most christian churches to this day.

It is very certain that the declension of Roman architecture began to make its appearance in the reign of Constanstine, shortly after his conversion to christianity; but it does not appear that he favoured or promoted this style in the foundation of his city of Constantinople.

During this period, until the sixteenth century, Gothic architecture continued to supplant all other styles, and during a few centuries was practised throughout Europe. Charlemagne introduced it into France, when many magnificent churches were erected, which continue to be the ablest specimens of the style to this day. The Roman style again revived, when the term *Gothic* was applied, in derision, by the Italian school of Palladio.

The variety of features it underwent, in its application to church architecture, has given rise to many speculations of men of science and learning, as to its rise and progress. One of the theories, and not an improbable one, is, that, during the crusade, worship was conducted in the groves, and in order to procure shelter and shade, they bent the limbs of opposite limbs together at the top, and bound them at the intersection, thereby producing the pointed arch, a continuation of which method from tree to tree would furnish a complete Gothic arcade. The Saxon and Norman Gothic was the first practised, and seems to have been constructed with considerable reference to the Roman style of its time. The pillars massy, and consisting of several shafts, cylindrical, and octagonal, supporting a heavy decorated cornice, ornamented with diamond net-work. The capitals composed of leaves and flowers.

One of the finest features of this style, and which in many instances form the most striking ornaments of a city, is the tall tapering spire; they were first built of wood by the Normans, and since with as much dexterity, by their descendants in stone, as in Salisbury Tower and spire, being 400 feet in height.

The most remarkable property belonging to the Gothic is magnitude; as it never succeeds in producing its characteristic beauties when projected on a small scale, and should always be constructed of stone or wood.

Buildings of a public nature ought to express, in the design, the uses and purposes to which they are erected and appropriated, so that strangers, when they behold a church, bank, court-house, prison, &c. may understand them to be so, from some external characters, without the aid of a painted sign or inscribed tablet.

Allegorical representations, applied to architecture, is a source through which we always derive pleasure and information, by calling forth the taste, judgment, and literary acquirements, to the interpretation of objects in the fine and dignified arts. In a young country like ours, where its inhabitants are scattered over an immense tract of territory, a great portion of which is unsettled and uncultivated; and where its only resources are drawn from agriculture and commerce, distributing and equalizing wealth, it cannot be reasonably expected that architectural works of great magnificence and duration should be constructed, to bear any kind of comparison with those executed under the controul of a despotic power, where materials, labour, and funds, are directed by sovereignty and an independent priesthood.

The associations of men of wealth for the construction of edifices of a public nature, and in the establishment of institutions for the promotion of the fine arts and sciences, are highly honourable to the taste and liberality of the American character: and it is entirely owing to such objects and exertions, that we can trace

the advancement of them in this country to the summit of their present perfection.

The native enterprize and perseverance of the country at large, in the advancement of science and art, has fully evinced itself in the many flourishing and populous cities spread over an immense continent, that two centuries ago was the abode of man in a state of nature.

The splendid and extensive edifices at Washington, Baltimore, Philadelphia, and New-York, exhibit great taste in the science of architecture. The capitol at Washington is perhaps the greatest effort of our republic, in point of extent and workmanship, and reflects great credit on the talents of Mr. Latrobe, the architect. The next in point of magnitude is the city hall in New-York, and a number of beautiful churches built of stone.

The Pennsylvania bank in Philadelphia, also from the designs of Mr. Latrobe, is the most beautiful building on the continent, and is a perfect model of a Grecian hexastyle temple; it has never failed to be universally admired, for its symmetry and proportion. "The value attached to works of this nature may be judged of, from the city of Ephesus refusing to suffer the temple of Diana to be inscribed with the name of Alexander the Great, although that prince offered to purchase that honour by defraying the whole expense attending its erection; from the Athenians rejecting a like offer from Pericles, with regard to the splendid and extensive edifices with which *he* had ornamented Athens; and from the city of Gnidia refusing to part with one statue, the Venus of Praxiteles, although king Nicomedes proposed to free them from tribute, if they complied with the request." [Wm. Strickland, *Architect.*]

In the vast structures of Asia and Africa, greatness of design, ponderosity of parts, and stones of immense magnitude, seem to have been more regarded than elegance or utility: in all those great works there is no trace of an arch, but what is excavated out of the solid rock, or may be made of a single stone. The Greeks profess to have derived the knowledge of architecture from the Egyptians, but the art of building has been so much improved by transplanting, that scarcely any trace of the original remains: their edifices were at first constructed of wood and clay, but they soon began to imitate the wooden posts and beams of the original hut in stone and marble: from this imitation arose the first order in architecture, which also gave birth to two others. This ingenious people, favoured by nature with marble and other building materials, and, like the Egyptians, being anxious to make their works durable, employed very weighty stones in the construction, which, although laid without cement, as was the practice of all ancient nations, yet they were jointed with the utmost accuracy, which is the reason of the perfect state of their edifices at this day. There is little doubt but that the Greeks were the inventors of the arch, though they never considered it as an ornament: it is only to be found in the theatres and gymnasia, the apertures of walls and intercolumns being linteled.

Greece, though a mild climate, is sometimes liable to rain: the architects of this country, therefore, found it necessary to raise the roofs of their edifices to a ridge in the middle, the section being that of a rectilineal isosceles triangle: the base being the span or distance between the opposite walls. This form of roof, called a pediment roof, was frequently covered with marble tiles.

The Grecians surpassed all contemporary nations in the arts of design; the remains of their ancient structures are models of imitation, and confessed standards of excellence. They were the inventors of three orders of architecture, of which we have already hinted, and which we shall detail in a subsequent part of this article. The remains of their sculptures far exceed that of any other people, and are, even at this day, most perfect models. Modern artists have no means so certain, in attaining a just knowledge of their profession, as in the study of those exquisite master-pieces.

The progress of Grecian architecture appears to have occupied a period of about three centuries, from the age of Solon to the death of Alexander; and in this period it advanced rapidly, particularly from the defeat of Xerxes to the death of Pericles, at which time it attained its utmost degree of excellence, and continued to flourish till the time it became a Roman province.

Prior to the Macedonian conquest, all the temples of Greece, and its colonies in Sicily and Italy, appear to have been of the Doric order: and of one general form, though slightly varied in particular parts, as occasional circumstances might require: their plan was an oblong, having one column more on the flank than double the number of those in front.

The ancient Etrurians have left many excellent monuments of taste, and to them

is generally ascribed the method of building with small stone and mortar, made of calcareous stone; and this seems probable, as the most ancient vestiges of cementitious buildings are to be found in the country which the present Tuscans inhabit.

They were employed by the Romans in many public works; the walls of the city of Rome were made of hewn stone, the capitol and the cloaca maxima are of their construction; the last of these is esteemed a very extraordinary piece of architecture, as is sufficiently proved by its remains. To these people is attributed the invention of one of the orders of architecture, called after them the Tuscan.

We are told by Vitruvius, that the intercolumns of their temples were wide, and that they were linteled with wooden architraves.

The Romans appear to have had their first knowledge of archirecture from the Etrurians: but it was not till after the conquest of Greece, that they acquired a just relish for its beauties. It seems to have attained to its highest degree of excellence in the reign of Augustus, and continued to flourish till the seat of empire was removed to Bizantium. The works of the Romans were much more numerous than those of any other people. The remains of their palaces, theatres, amphitheatres, baths, mausoleums, and other works, excite at this day the admiration and astonishment of every judicious beholder. Their first temples were round and vaulted, and hence they are accounted the inventors of the dome.. The plans of their buildings were more varied than those of the Greeks, who, excepting but in a few instances of small, but beautiful, specimens, such as the Tower of the Winds, and the monument of Lycicrates, erected their principal edifices upon rectangular plans. The Romans constructed circular temples crowned with domes, amphitheatres upon elliptic plans, and their theatres, and many other buildings, upon mixt-lined plans. By this variety they formed a style that was both elegant and magnificent. But let it be remembered, that, notwithstanding the grandeur, the magnitude, and number of their works, their style was never so pure as in the flourishing ages of Greece. Among the Romans, entablatures were frequently omitted: columns were made to support arches and groined vaults; arcades were substituted for colonades, and vaults for ceilings. In several of their most magnificent public buildings, we find stories of arcades upon each other, or in the same front with the solid parts of the masonry, decorated with the orders, which, instead of forming an essential part in the construction, are degraded to idle and ostentatious ornaments. This is very conspicuous in the theatre of Marcellus, and in the Coliseum.

It is probable that the arch was invented in Greece, but was almost constantly employed by the Romans, who not only considered it necessary in the construction, but as an ornament, which they lavishly employed in the apertures of walls, and in the ceilings over passages and apartments of their buildings. Particularly in the decline of the empire, from the reign of Constantine, and upon the establishment of Christianity, external magnificence was every where sacrificed to internal decoration. The purity of taste in the arts of design declined rapidly, and finally perished with the extinction of the empire. The most beautiful edifices, erected in the preceding reigns, were divested of their ornaments, to decorate the churches. In this age of spoliation, architects, deficient in the knowledge of their professions, adopted the most ready modes of construction: to accomplish this, many beautiful structures were deprived of their columns, and placed at wide intervals in the new buildings; and over the capitals were thrown arches for the support of the superstructure: most of the ornamental parts were taken from other buildings, which were spoiled for the purpose. The edifices of Italy now assumed the same general features as those which characterised the middle ages. This disposition is the plan of the Roman basilicas, but is more nearly allied, in the elevation, to the opposite sides of the Egyptian oeci, which has also the same plan as the basilica, and which was of similar construction to the churches in after times, excepting in the want of arches: both had a nave, with an aisle upon each flank, separated from the nave by a range of columns, which supported a wall, pierced with windows for lighting the nave: against this wall, and over the columns, were placed other attached columns. This, when roofed over with a groined sealing, such as that of the Temple of Peace, will form the interior of a building similar to that of the Saxon churches.

The Corinthian order was the favourite order among the Romans, and, as far as existing examples enable us to judge, the only order well understood, and happily executed.

What we now call the Composite order is of Roman extraction: it was employed in many of their buildings, but chiefly in the triumphal arches: from what we find in Vitruvius, it was never accounted a distinct order, but as a species of the Corinthian only. The only existing example that Rome affords, of the Doric order, is that executed in the theatre of Marseilles, and, though in the age of Augustus, is but a vitiated composition: the columns are meagre and plain, divested of that sublime grandeur and elegance which are so conspicuous in the solidity and flutings of the Grecian Doric. The dentils in the cornice are too effeminate a substitute for the masculine mutules, which are so characteristic of the origin of this order.

The Ionic in the same building is ill executed. The channels of the volutes, of the capitals, of the Ionic columns on the Coliseum, and the dentil band of the cornice, are not cut. The Ionic order of the Temple of Fortune, though it has been held out as a model, is ill proportioned, and the spirals of the volutes are ungracefully formed. The Ionic of the Temple of Concord is out of character, the volutes are insignificantly small, and mutules supply the place of dentils in the cornice. The Romans placed one order upon another, on the exterior, in the several stories of some of their buildings; but the Greeks only employed them around the cells of their temples, forming a peristyle.

The Romans carried the method of cementitious buildings to the utmost degree of perfection. Their most considerable edifices had the facings of their walls, and the arches and angles of brick, or small rubble stones squared; the cores built with pebble and rubble stones, grouted or run with liquid mortar; and at regular intervals were strengthened with courses of bond stones. This construction of walls was frequently stuccoed, or incrusted with marble. It is much more expeditious and economical than that built of wrought stone, which occasions a greater waste of materials and loss of time. The durability and solidity of the Roman cementitious buildings is such, that mortar has acquired a hardness superior to the stones which are connected by it. This, when compared with the fragility and crumbling nature of the mortar used by modern builders, had led some to suppose that the ancients possessed processes in the making of cements, which have, from the lapse of time, been lost to the present day. But the information and experiments of ingenious men have exploded this opinion; and there is no doubt, that, if proper attention be paid to the choice of limestone and sand, to the burning of the lime, and above all, that care be taken in the mixing and tempering these materials, workmen will be enabled to rival those of Rome. This has been tried in some instances, though the lapse of ages may be necessary to make the comparison complete; however, it will appear, from the following account of Vitruvius, that the method of making lime by the Romans was not very different from what it is at the present day. "Lime should be burnt from white stone, or flint, of which the thick and hard sort are more proper for building walls, as those which are porous are for plastering. When the lime is burnt, the ingredients are thus to be mixed: with three parts of pit sand, one part of lime is to be mingled; but if river or sea sand is used, two parts of sand and one of lime must be united; for in these proportions the mortar will have a proper consistence; if bricks, or tiles, pounded, and sifted, be joined with river or pit sand, to the quantity of a third part, it will make the mortar stronger and fitter for use."

The works of wrought stone of the Romans, as well as those of the Greeks, were constructed without cement; but cramps and ligatures of iron and bronze were used in great abundance. The use of metal was not confined to cramps and bolts, for they even constructed roofs of bronze, which was also used in magnificent profusion in the decorations of buildings. It excites regret, to reflect that the means employed by the ancients to increase the beauty, and ensure the duration of their edifices, have only, in many instances, served to accelerate their destruction.

These valuable materials have caused much dilapidation, and more buildings have been ruined by rapine, than by the injuries of time. In the works of the Greeks and the Romans, of hewn stone, they appear to have wrought only the beds of the stones, before they were placed in the building, leaving the faces to be worked after the completion of the edifice. By this means, the arisses and the mouldings were preserved from injury, and the faces made exactly in the same plane, or surface, which is not generally the case in the facings of our modern works. Our workmen pass them over in the most slovenly manner, with the greatest indifference, by rounding the stones which happen to project at the joints, which gives them a false and irre-

gular appearance in sunshine. By this means, also, the ancients diminished and fluted their columns, which could not be done with the same accuracy any other way.

After the fall of the Roman empire, the Goths, having now the dominion of those places formerly the seat of the arts, and having soon become converts to Christianity, but having no established rules of their own in the principles of architecture, either built their churches in the form of the Roman basilica, or converted the basilica into churches. Architecture continued during their government with little alteration, in the general forms, from that which had been practised at the decline of the Roman empire; but ignorance in proportion, and a depraved taste in the ornamental department, at last deprived their edifices of that symmetry and beauty, which were so conspicuous in the works of the ancients. However, the knowledge of architectural elements was still preserved among them, and of the various forms of vaulting used by the Greeks and Romans, they adopted that of groins or cross-arching.

From what has been said, it will be easy to shew, that the Goths had no share in the invention of that style of building which still bears their name. The architecture of Italy, at the time they ceased to be a nation, was nothing but debased Roman, which was the archetype for the first Saxon churches erected in this country. The term Gothic seems to have originated, in Italy, with the restorers of the Grecian style, and was applied, by the followers of Palladio and Inigo Jones, to all the structures erected in the interval between the beginning of the twelfth and end of the fifteenth centuries, probably with a view to stigmatize those beautiful edifices, and to recover the ancient manner. This term is therefore of modern application: it was not used in Italy till the pointed style had gained the summit of perfection, nor yet in England, when this species of architecture ceased to be in use, and the Grecian restored. This manner of building, like most other arts, required a succession of ages to bring it to maturity, and the principal cause which seems to have effected this was, that desire of novelty so inherent in the mind of man to produce something new, and a total disregard to the proportions of ancient edifices. Having now traced the Grecian style from the place of its invention to its decline in Italy, we shall follow the steps by which this corrupted ill-proportioned Italian style at last assumed a character so different from the original, as to become in a few centuries a distinct species of architecture, which not only exhibited beautiful proportions, and elegant decorations, but also majestic grandeur and sublimity in its fabrication. To do this it will not be necessary to seek abroad for those successive changes, as the different gradations can be distinctly traced at home. The first Saxon churches here were either constructed, with however rude imitation, after models of Roman temples, which we may presume then remained in Britain, or by foreigners brought from Rome and France. The manner of building at this time was called Roman, the term Gothic not being applied till the end of several centuries.

It has been observed, that a quadrangular walled enclosure, divided in the breadth into three parts, by two colonaded arcades, supporting, on the imposts of the arches, two other opposite higher walls, through which the light descended into the middle part, and upon which the roof rested, was known to the Romans before the Goths appeared in Italy. Now this construction is the general outline of the Saxon, Norman, and the pointed styles of building churches, and is also that form of structure most advantageous for lighting the interior, upon the same plan; for, though the roof might have been equally well supported by columns, instead of the interior walls, and extending those of the exterior to the whole height, the intensity of light produced from the same number of windows on the sides, thus far removed from the middle of the edifice, would have been greatly diminished. It may also be farther observed, that no other form of building was so favourable for vaulting: for a vaulted roof could neither have been thrown to the whole breadth, nor in the three compartments, without walls of enormous thickness, which would not only have added to the breadth, but would have been attended with prodigious additional expenses.

The Saxon style is easily recognized by its massive columns and semicircular arches, which usually spring from capitals without the intervention of the entablature. In the first Saxon buildings the mouldings were extremely simple, the greater part consisting of fillets and platbands, at right angles to each other, and to the general façade. The archivolts and imposts were similar to those found in Roman edifices. The general plan and

disposition of the latter Saxon churches were as follow; the chief entrance was at the west end into the nave, at the upper end of which was a cross, with the arms of it extending north and south; the east end, containing the choir, terminated in a semicircular form. A tower was erected over the centre of the cross, and to contain the bells another was frequently added, and sometimes two.

The large churches contained a nave and two side aisles, one on each side of the nave, and were divided into three tiers or stories, the lower consisting of a range of arcades on each side; the middle, a range of galleries between the roof and the vaulting of the aisles; and the uppermost, a range of windows. The pillars were either square, polygonal, or circular. Such was the thickness of the walls and pillars, that buttresses were not necessary, neither were they in use. The apertures are splayed from the mullions on both sides. The dressings are generally placed on the sides of the splayed jambs and heads of the arches, and but seldom against the face of the walls, and when this is the case, the projectures are not very prominent. The dressings of the jambs frequently consist of one, or several, engaged columns upon each side. The imposts, particularly those of the windows, have frequently the appearance of being a part of the wall itself. The doors in general are formed in deep recession, and a series of equidistant engaged columns placed upon each jamb, and were such, that two horizontal straight lines would pass through the axis of each series, and would, if produced, terminate in a point. Each column is attached to a recess formed by two planes, constituting an interior right angle. The angle at the meeting of every two of these recesses formed an exterior right angle, which was sometimes obtunded, and frequently hollowed. The archivolts resting on the capitals of the columns are formed on the soffit shelving, like the jambs below. The ornaments of columns and mouldings are of very simple forms. The rudely sculptured figures which often occur in door-cases, when the head of the door itself is square, indicate a Roman original, and are mostly referable to an æra immediately preceding the conquest.

After the Norman conquest, the general forms of the parts remained the same, though the extent and dimensions of the churches were greatly enlarged; the vaultings became much more lofty, the pillars of greater diameter, the ornaments more frequent and elaborately finished; towers of very large dimensions and great height were placed either in the centre, or at the west end of the cathedral and conventual churches. These were often ornamented with arcades in tiers of small intersecting arches on the outside. About the end of the reign of Henry I. circular arches, thick walls without prominent buttresses, and massive pillars with a kind of regular base and capital, generally prevailed; the capitals of the pillars were often left plain, though there were a few instances of sculptured capitals, foliage, and animals. The shafts of the pillars were usually plain cylinders, or had semicolumns attached to them. The first transition of the arch appears to have taken place towards the close of the reign of Stephen, its figure, which had hitherto been circular, becoming slightly pointed, and the heavy single pillar made into a pilastered cluster, which was at first ill formed, but gradually assumed a more elegant figure and graceful proportion, the archivolts still retaining many of the Saxon ornaments. It may here be observed, that, antecedent to this period, neither tabernacles nor niches with canopies, statues in whole relief, pinnacles, pediments, or spires, nor any tracery in the vaultings, were used; but at this time, or soon after, these began to obtain. Towards the close of the 13th century, the pillars, then supporting sharply pointed arches, were much more slender; the ceilings were seemingly sustained by groined ribs, resting on the capitals of the pillars, and the windows were lighted by several openings, in place of one.

After the reign of Stephen, the circular and pointed arches were frequently employed in the same building; but the pointed style, gaining more and more upon the circular, prevailed ultimately at the close of the reign of Henry III. and prevented all farther confusion of mixture. The architecture of this age now exhibited uniformity of parts, justness of proportions, and elegance of decoration; the arcades and pillars became numerous, the single shafts were divided into a multiplicity of equal, slender, distinct shafts, constructed of purbeck marble, and collected under one capital, luxuriantly decorated with leaves of the palm-tree. The east and west windows began to be widely expanded; these required a number of mullions, which, as well as the ribs and transomes of the vaulting, began to ramify, from the springing of the arches, into a

variety of tracery, which was uniformly ornamented with rosettes or polyfoil, cuspidated figures, forming trefoils, quatrefoils, &c. Canopies were introduced over the arches, and in rich work were decorated with crockets and creeping foliage, and terminated in a flower. The buttresses were made in several diminished stages towards the top, and mostly terminated with purfled pinnacles.

In the reign of Edward II. detached columns were laid aside, and pillars, nearly of the same proportion as formerly, with vertical or columnar mouldings wrought out of the solid, were adopted. The east and west windows were so enlarged as to take up nearly the whole breadth of the nave, and carried up almost as high as the vaulting, and were beautifully ornamented with lively colours on stained glass.

In the early part of the reign of Edward III. arcades with low arches and sharp points prevailed; over the arcades was generally placed a row of open galleries, originally introduced in Saxon churches.

About the end of the reign of Richard II., A. D. 1399, the pillars became more tall and slender, forming still more lofty and open arcades; the columns which formed the cluster were of different diameters, the capitals more complicated, the vaults at the intersection of the ribs were studded with knots of foliage, the canopies of the arches were universally purfled, and terminated with a rich knot of flowers: the pilastered buttresses flanking the sides were crowned with elaborate finials, the flying buttresses were formed on segments of circles, in order to give them lightness, and strength at the same time.

From the close of the 14th century no remarkable change appears to have taken place; the grander members continued their original dimensions and form, and the ornamental parts became distinguished by greater richness and exuberance.

Another change took place in the reign of Edward IV. Its leading features are principally to be seen in the vaultings, the horizontal sections of which had been generally projecting right angles, but were now arches of circles; the surface of the vaults being such as might be generated by a concave curve revolving round a vertical line, as an axis which was immediately over the pillars. This species of groining, unknown in preceding ages, was favourable for a beautiful display of tracery. Equi-distant concave ribs in vertical planes were intersected by horizontal convex circular ribs, and the included pannels were beautifully ornamented with cusps, forming an infinite variety of the most elegant tracery, which, from its appearance, has been denominated fan work.

From the commencement of the reign of King Henry VIII. a mixed or debased style began to take place, from our intercourse with the Italians. The ingenious Mr. Britton, in his valuable architectural antiquities of Great Britain, has classed the various styles in the following order, which we shall adopt, and shall be happy to find the same appropriate terms adopted also in future publications, wherever ideas of the objects represented by them are the subjects of inquiry. We are sensible this is the only means of facilitating a knowledge of this study, by removing equivocal words, and thereby making architectural language intelligible.

First Style. Anglo Saxon; this will embrace all buildings that were erected between the times of the conversion of the Saxons and the Norman conquest, from A. D. 599 to A. D. 1066.

Second Style. Anglo Norman, by which will be meant, that style which prevailed from 1066 to 1189, including the reigns of Williams I. and II., Henry I., Stephen and Henry II.

Third Style. English, from 1189 to 1272, embracing the reigns of Richard I., John, and Henry III.

Fourth Style. Decorated English, from 1272 to 1461, including the reigns of Edwards I., II., III., Richard II., Henrys IV., V., and VI.

Fifth Style. Highly decorated florid English, from 1461 to 1509, including the reigns of Edwards IV. and V., Richard III., and Henry VII.

From this æra we lose all sight of congruity: and the public buildings erected during the reigns of Henry VIII., Elizabeth, and James I., may be characterised by the terms of debased English, or Anglo-Italian. Mr. Britton observes, "that during the intermediate time, when one style was growing into repute and the other sinking in favour, there will be found a mixture of both in one building, which is not referable to either, and which has constituted the greatest problem in antiquarian science."

Before we leave this subject, it will be necessary to give some account of the materials employed in the fabrication, and of the principles in the construction of those immense piles, which at once united grandeur, magnificence, and awful sub-

limity in their structure. In the erection of these edifices, heavy cornices, entablatures, and lintels, were omitted, and there was seldom occasion to use any stones larger than a man might carry on his back, up a ladder, from one scaffold to another, though spoke wheels and pullies were occasionally used. From the adoption of such light materials, and the emulation of the architects, edifices were raised to an incredible height. Hence the lofty towers, and the still more elevated spires that occasion such awful grandeur, and sublime sensations in the mind of the astonished beholder. The ceilings of the churches were formed by groined vaulting, a portion of the pressure of which was directed in the length to the ends, and the remaining pressure to the springing points on the sides.

In the Roman buildings the walls were most commonly without projections, and of vast thickness, which was necessary in a vaulted building, erected upon a rectilineal plan, in order to counteract the efforts of the resisting arches. Hence, if the building had been groined, the weight of the arches would have been thrown upon the springing points. From this it is evident that a vast quantity of materials must have been employed without effect; but this is not the case with the pointed style of architecture, for the walls were thickened by buttresses opposed only to the pressing points; and, to aid the resistance with still more powerful effect, the buttresses were surmounted with high pinnacles, and, from their sloping position, their general form was almost one continued prop, in a straight line to the bottom: this straight line was a tangent to the arch. Those that understand the nature of the centre of gravity will easily perceive, that a plain wall will be overturned with much more ease than one with buttresses, of the same length and height, the same quantity of materials being employed in both. The extremity of the aisles was sustained by strong pilastered buttresses on the outside, and the other extremity rested on the imposts or capitals of the pillars. These pillars, with their superincumbent walls, not being assisted as on the outside with buttresses, were liable to be bent with the pressure of the arches, unless the sides of the nave had been of sufficient thickness, which, in many of our churches, experience has proved to be the contrary, by the bending of the walls inwardly, which is a serious defect, and threatens ruin to many of those venerable piles of building. We cannot therefore expect these edifices to rival, in duration, the immortal constructions of Egypt, Greece, and Rome. As to the groining of the nave, the arches were equally resisted on both sides by the flying buttresses, which pressed forcibly at the imposts of the arches. It would appear, that the method practised in the erection of these edifices was, to insert the springing stones as the work went on, but to leave the vaulting to be turned after the walls had been carried up to their full height, and the whole roofed in. The roofs of Gothic buildings were very high pitched, a form more from choice than necessity, rather adopted in compliance with the pointed and pyramidal style of architecture, than rendered necessary by the climate, being generally covered with lead. These roofs are therefore faulty, in burdening the walls with an unnecessary load of timber and lead; and they are also deficient in the construction, by the omission of tyebeams, to counteract their tendency to spread and thrust out the walls.

After having thus discussed the several styles of building, which have been generally and unmeaningly classed under the appellation of Gothic, we must now make a retrogression to Italy, where the Grecian style had been revived for a consider able time, and was flourishing in great purity. Let us therefore retrace the steps by which it again rose to its ancient splendour and magnificence.

Fillipo Brunelleschi, born 1377, may be looked upon as the restorer of ancient architecture, and the founder of the modern style.

After having prepared his mind by the study of the writings of the ancient authors, and the ruins of Roman edifices, which he careftlly measured, he discovered the orders, and recognized the simple forms and constructions of the ancients, and having thus formed a system upon unshaken principles, he was enabled to construct works with beauty, solidity and durability. He erected the dome of St. Maria da Fiore at Florence, an undertaking beyond the abilities of any other builder then living; Arnolfo, the original architect of this vast cathedral, having been two years dead. This dome, rising from an octangular plan, is of great elevation, and is only inferior in size to that of St. Peter's. It is constructed by two vaults, with a cavity between them, and was erected without centering. It is the only elevated dome supported by a wall without buttresses. From this, and many

other buildings erected by Brunelleschi, the learned began to study the works of Vitruvius, and a general taste for the principles of the art began to warm the breasts of the Italians.

Leo Battista Alberta, born A. D. 1398, was the first modern author who published a learned treatise on architecture, from which he has acquired great reputation, and is justly styled the modern Vitruvius. Following the steps of Brunelleschi, he reformed by his precepts and designs many of the abuses and barbarous practices which then prevailed among his countrymen.

Bramante had a considerable share in the restoration of ancient art, and built many magnificent edifices. Pope Julius II. having projected the rebuilding of St. Peter's upon a scale of unequalled magnificence, entrusted the execution of the design, 1513, to Bramante, who conceived the idea of erecting the lofty cupola upon that immense structure. This vast undertaking was carried on successively by Raphael, San Gallo, and Michael Angelo, to whom the final design and completion of the work is principally due.

Architecture continued to flourish in the 16th century, under the great architects Vignola, Serlio, Palladio, and Scamozzi. To the unremitted assiduity of these distinguished artists in the study of the Roman edifices, and to their invaluable publications, the world has been much indebted for the elucidation of the principles of ancient art.

The list of the celebrated Italian artists closes with Bernini, who flourished in the 17th century.

The Grecian style of building was revived in France in the beginning of the 16th century, and afterwards flourished under several architects of distinguished merit. Their principal works are, the palace of Versailles, St Cyr, the church of Invalids, the Facade of the Louvre, a most beautiful modern structure, the Porte St. Dennis, and the church of Genevieve, the present Pantheon.

Grecian architecture was restored in England under the celebrated Inigo Jones, born 1752. His distinguished works at Greenwich, Whitehall, and Covent Garden, will ever secure him a name among the architects of the highest reputation.

Sir Christopher Wren, an eminent mathematician and philosopher, as well as an architect of the first rank, has executed many of the finest buildings in London, and other parts of England, in the modern style. St Paul's cathedral, inferior to none but St. Peter's, in point of magnitude, but perhaps superior both in skilful construction and figuration, will perpetuate his name to the latest posterity. The exterior dome of St. Paul's is constructed of wood, and sustained by a cone of 18 inch brick-work, which also supports the lantern above.

The interior dome is also constructed of 18 inch brick work, which had a course the whole thickness for every five feet, and the intermediate parts had two bricks in length in the thickness. This dome was turned upon a centre, which supported itself without any standards from below. From the inclined position of its supporting walls it had little or no transverse pressure, yet, for the greater security, it was hooped with iron at the bottom. This is accurately represented in Gywn's Section.

Though modern architecture is, for the far greater part, indebted to the constructions and decorations of Grecian and Roman edifices, yet we still retain considerable traces of the Gothic style in many of our buildings.

The spire is of Gothic invention; it is imitated in our churches and some other buildings, by erecting one, or two, or a series of Grecian temples over each other, every superior one being less in its horizontal dimensions than that immediately below.

Frustrums of pyramids and cones are also the ornaments of our steeples; but whether the component parts be one, two, or a series of temples, continually diminished, or temples supporting truncated pyramids, the general contour of the aggregate is still pyramidal.

The plans of Grecian buildings were simple geometrical forms; but these of our structures are symmetrical and complex figures, more in imitation of those of the Romans.

The materials used in our modern buildings are stone, brick and timber. In rustic buildings, the stones are either laid dry or with mortar. In finished edifices, the stones of the facings are squared and laid in mortar, and the backs and cores are most generally made up with brick or rubble. Walls constructed entirely of squared stones are rare: for, allowing the materials may be easily procured in great abundance, a vast expense will be incurred by enormous additional workmanship. This construction of walling is therefore seldom or never used but in aquatic buildings, where the greatest strength is frequently necessary.

The French have not only shown much ingenuity in the binding and cementing

of walls, but also in the cutting of stones with geometrical exactness, so as to fit vaulted surfaces, of variously formed figures.

Iron is used for cramping stones, sometimes in binding the face and back of a wall together, when there is little heart. In domes it is frequently used in circular chains, in order to remove lateral pressure, and make the weight of the superstructure act perpendicularly upon the supports. It is also used in fastening wood together, and wood to stone work.

Timber is used also as ligatures to walls; in this situation it is called bond timber, which also serves for securing the internal finishings. Timber is frequently used in foundations, in floors, in roofing, in internal finishing, &c. Timber, besides being used in bond, flooring, and roofing, in conjunction with stone or brickwork, is sometimes used as the only material, excepting the chimnies, nails, and other iron fastenings.

Mouldings. In architectural decorations, the materials are formed into a variety of shapes; which have in any two places sections of equal and similar figures, at right angles to their surface, in these two places; thin forms of this property are called mouldings.

When the section is semicircular, or semielliptical, it is called a torus or astragal: when large, it is called a torus; and when small, an astragal.

When the section is a concave curve, and when the concavity recedes beyond either of the extremities of the curve, the moulding is called a scotia or trochilus.

When the section is concave, one extremity being above the other and the upper extremity projecting out beyond the lower, and when the lower extremity recedes from a vertical line equal to the greatest recess of the concavity, or more, the moulding is called a cavetto.

When the section is a convex curve with one extremity below the other, and the upper extremity projecting farther than the lower, without any part of the convexity being lower than the lower extremity of the section, the moulding is called an ovolo or echinus.

When the section is a curve of contrary flexure, like a flat S, the moulding is called an ogee; and when the concave part of the ogee projects, and the convex part recedes, the ogee in this position is called a sima recta: but when the parts lie the contrary way, it is called a sima inversa.

When the section is straight, and is either perpendicular to the horizon, or nearly so, then the flat member is called a fillet, plat-band, or facia, according to its breadth and comparison with other contiguous mouldings.

When it is very narrow, and either crowns an upper moulding, or divides one member from another, it is called a fillet, or listello; when it is broader, it is called a plat-band or plinth; and when very broad, it is called a facia or face.

Compound Mouldings. When one, two, or a collection of mouldings, with or without fillets, crown a broad flat member, this collection is called a cymatium. Other names are particularly applied to the orders, and are explained under that head.

ORDERS OF ARCHITECTURE.

An order is a decorated imitation of those primitive huts, which consisted of rows of posts, made of the trunks of trees, disposed in the ground around a quadrangular plat; and supporting a covering, which consisted of four lintelling beams, placed on the top of the posts, with other transverse beams, supported again by two of the opposite lintels: and lastly, of three rows of transverse timbers supporting each other, and the lowermost supported by the ends of the transverse beams on each side, in parallel inclined planes, rising from the ends of the transverse beams, till each plane of timbers on the one side met its corresponding plane on the other; the lowermost timbers on each side being disposed in pairs, in the same vertical plains with the transverse beams, forming the sides of a triangle, and projecting beyond the lintels, and the uppermost inclined planes of timbers, serving to fix the covering of tyle or stone. From this simple construction arose the first order of architecture called

Doric Order. The columns were imitated from the wooden posts tapering upwards, as trees do by nature, and placed upon a stone base, to prevent them from sinking: vertical channels, or flutes, were cut in the shafts, to hold the spears, or staves, which the early Greeks carried along with them. The capital was formed by circular stones, laid on the tops of the columns, and square ones again upon these, to protect the shafts from rain, and to receive the lintelling beam, which became the architrave: the ends of the joists over the architrave were not in vertical channels, forming the triglyphs, for preventing the rain from adhering to them. The cornice was formed by the

projecting timbers of the roof; the ends of the bottom tier of these timbers forming the mutules: the lower sides of which, as well as the under side of the band of the triglyphs, were cut into thin cylinders, or conic frustrums, representing the drops of rain falling from the edges. These parts, which at first resulted from the primitive habitation, were afterwards converted into more elegant decorations of simple and natural forms. The general figure of the Attic Doric consists of but few parts, even as practised in the most refined ages of Greece: the fluted shaft, terminating with one, two, or three annular channels; the capital, consisting of the fillets, and a bold echinus, having the same common axis with the shaft; and the crowning abacus form the entire column, which therefore consists of a base and shaft. The spacious architrave, resting on the columns, consisting of a crowning band, with the guttere and tenia pending therefrom, under the triglyphs; the frize, consisting of a capital, or cymatium, and equidistant triglyph, leaving square recesses between them, called metopes; and the cornice, consisting of mutules over the triglyphs and over the metopes; the corona formed of a band and cymatium above; and the sima, or crowning moulding, formed of a large ovolo and fillet, compose the whole entablature; which therefore consists of a cornice, frize, and architrave. This is the general character of the Grecian Doric. It is almost constantly placed upon three steps, proportioned to the height of the order, and not to the human step; the shafts of the columns diminish, with a beautiful curve line from the bottom to the cincture below the annulets; the flutes are without fillets, of a circular or elliptic section, and terminate immediately below the annulets: the annulets of the capital most commonly follow the contour of the ovolo; above them, the band, crowning the top of the architrave, is one continued string without breaks; the guttæ under the regula, and under the mutules, are generally of a cylindrical form, at least tapering upwards in a very small degree.

The triglyphs are placed upon the extremities of the frize, and not over the axis of the extreme columns; and consist of two whole channels, and two half ones upon the edges; the sides of each glyph, or channel, are two vertical planes, meeting each other in a right angle at the back, and consequently the face of the triglyph at 135 degrees on each side of the glyph; the tops of the channels are sometimes curved in the front, like a very eccentric semi-ellipsis, placed with its greater axis horizontal, as in the temple of Theseus; and very frequently with a horizontal line, joined to each vertical line at the side, with a quadrant of a circle, and the tops of the two half channels on each edge of the triglyph are semicircular, not only in front, but in the profiles also, leaving the angle pendant at the top, as in the temples of Minerva at Athens, and at Sunium, and the temple of Jupiter Panellenius; and sometimes the head of the glyph is horizontal, as in the Doric portico at Athens, and in the temple of Jupiter Nemæus, between Argos and Corinth.

In all these examples, the surface forming the head of a glyph is perpendicular to the front, or such that a right line, perpendicular to the face, and touching the top line of the head in any point, will coincide with the surface of the interior of the glyph. The capital of the triglyphs has a small projection on the face, which is not returned on the edges, and descends lower than that over the metopes; though both are on the same level at the top.

The mutules are thin parallelopipeds, their lower surface making an acute angle with the upright of the frize, in the same manner as the under ends of the rafters of the primitive hut would; the pendant guttæ, hung to them, are in three rows, from front to rear, having six on the front, and also in each of the two back rows. The soffit of the corona is parallel to that of the mutules, and consequently makes an acute angle with the upright of the frize also. The lower part of the corona is most frequently wrought into a fillet; its cymatium is differently formed in different examples, but most frequently with a small ovolo and fillet, both of which are channelled upwards, in order to produce a greater variety of light and shade. The sima, or crowning moulding, most frequently consists of a large ovolo, and a fillet over it.

The general proportions of the Doric order are the following. The columns are six diameters in height: the superior diameter is four-fifths, and the altitudinal dimension of the capital two-fifths of the inferior diameter, including the annulets, echinus, and abacus. The height of the capital is divided into two equal parts, giving the upper one to the abacus, and the lower one to the echinus and annulets: divide the lower one into five parts, giving one to the annulets, and four to the ovolo: divide the height of the entablature into four parts, giving one to

the cornice, which comprehends the distance between the fillet of the echinus or crowning moulding and the under side of the guttæ; divide the remaining three into two equal parts, giving one to the height of the frize, as seen in front, and one to the architrave.

The Doric order was the only order known in Greece, or its colonies, anterior to the Macedonian conquest. The Ionic succeeded, and appears to have been the favourite order, not only in Ionia, but all over Asia Minor. The Corinthian (says Mr. Wood) came next in vogue, and most of the buildings of this order seem posterior to the time of the conquest of those countries by the Romans. The first Doric building was the temple of Juno, erected by Dorus, king of Achaia, and Peloponnesus in the ancient city of Argos, from whom this order derives its name. It was also used in other cities of this prince's dominions, but its proportions were not established, till an Athenian colony erected a temple to Apollo Panionos, in Ionia, so called from Ion, their leader, after the form of the temples they had seen in Achaia. In this building the relative dimensions of the columns were adjusted, from the ratio which the foot of a man bears to his height, making their diameter one sixth part of their altitude.

Ionic Order. The ambitious desire of novelty soon led the way to the invention of another species; and, in erecting the temple of Diana, they sought a new order from similar traces, imitating the proportion and dress of women. The diameter of the columns was made an eighth part of their height; the base was made with folds representing the shoe; the capitals with volutes, in form of the curled hair worn upon the right and left; and the cymatium, for the locks pending on the forehead from the crown. This new order they called Ionic, after the name of the country in which it was invented: so far we are informed by Vitruvius. It is probable, that, in erecting this temple, the triglyphs and mutules, the bold characteristic marks of the original hut, would be omitted, and the more delicate dentils, representing the ends of the lath to which the tyles were fixed, employed, representing a beautiful row of teeth; for in all the ancient Ionian fragments of this order we find the cornices constantly denticulated, and therefore the dentils are no less characteristic marks than the capitals: they are generally omitted, however, in the remains of those to be found at Athens. The other parts and proportions of the Ionian order are more arbitrary than in the Dorian. The parts of the Ionic order on the temple by the Ilyssus are few, and of a bold character; the height of the volutes is three-fifths, and the whole height of the capital two-thirds, of the diameter of the column.

The architrave consists of one broad facia, and its crowning cymatium: the parts of the cornice as seen in front are, the corona, including its cymatium, and sima. The capital, or cymatium of the frize, is wrought under the cornice, and consists of a sima reversa, and bead below it. The height of the architrave is about two-fifths of the entablature; and by dividing the upper three-fifths again into five parts, the plain part of the frize will occupy three parts, and the cornice two parts.

In the Ionic order of the temple of Erechtheus, and of the temple of Minerva Polias, the architrave consists of three faciæ, and cymatium; the cymatium of the frize is mostly wrought under the corona. If the height of the entablature from the bottom of the lower facia to the top of the cymatium of the corona be divided into nineteen parts, the architrave and the part of the frize that is seen will each be eight parts, and the corona, including the larymer and cymatium, the other three parts. The volutes of the capitals of these orders, both for singularity and beauty, exceed every other remain of antiquity.

The Asiatic Ionian order differs greatly from the Attic one. In most of the remains of this order, as represented in the Ionian antiquities, the frizes are all wanting, except in one example; and consequently the whole height of the entablature of those without the frizes cannot be ascertained, though the architraves and cornices belonging to each other have been accurately measured. The one which has the entire entablature belongs to the great theatre at Laodicea: the frize is pulvinated, and is something less in height than one-fifth of that of the entablature. The architraves of the temple of Bacchus at Teos, and the temple of Minerva Polias at Prienne, are each divided into three faciæ below the cymatium. In all the Asiatic Ionics the crowning moulding is constantly a sima recta of a less projection than it has height: the dentils are never omitted, and their height is nearly a mean proportion between the height of the sima recta and that of the larimer, corona, or drip, being always greater than the height of the corona, and less than that of the sima recta.

The cymatium of the denticulated band is wrought almost entirely out of the soffit of the corona, or recessed upwards, and consequently its elevation is almost concealed. The height of the cornice, from the top of the sima to the lower edge of the dentils, is equal, or very nearly so, to that of the architrave. The altitude of the frize, without its cymatium, or upper mouldings, may be supposed to be about a fourth part of the whole entablature; for if higher than this, the entablature would be too great a portion of the columns for any analogy we are acquainted with. In point of beautiful proportions and elegant decorations, the entablatures of these two last examples exceed every other remain; and though their proportions are very different from those remaining at Athens, yet they are still pleasing.

In all the Grecian Ionics there seems to be a constant ratio between the upper part of the cornice, from the lower edge of the corona upwards, and the height of the entablature: this is nearly as two to nine. If these members were regulated in any other manner, their breadths would be so variable, as sometimes to be so diminutive that their forms could not be perceived, and at other times so enlarged as to overload the whole, when viewed from a proper station. Indeed the great recess of the mouldings under the corona makes this a very distinct division, and on this account we never think the cornice too clumsy, though the whole denticulated band and cymatium of the frize are introduced below the cornice, which seems to be the reason of so great an apparent difference between the Asiatic and Attic Ionics. This order, as found in the Ionian territory, is complete; but those at Athens are deficient, from their want of the dentil band, though beautiful in many other respects.

Moderns have added a diameter to the height of the Ionic column, making it nine instead of eight. The shaft is generally striated into twenty-four flutes, and as many fillets. The height of the entablature in general may be two diameters; but where grandeur as well as elegance is required, it should not be less than a fourth. The base employed in the Athenian Ionics consists of two tori, and a scotia or trochilus between them, and two fillets, each separating the scotia from the torus above and below: the fillet above the torus generally projects as far as the extremity of the upper torus, and the lower fillet beyond the upper torus; the scotia is very flat, and its section and elliptic curve joining the fillet on each side: the tori and scotia are nearly of equal heights; in the Ionic temple on the Ilyssus, a bead and fillet are employed above the upper torus, joining the fillet to the scape of the column: the upper torus of the basis of the same temple, and that of the basis of the temple of Erechteus, are both fluted, preserving the lower part, that joins the upper surface of the fillet above the scotia, entire. The upper scotia of the temple of Minerva Polias is enriched with a beautiful guilloche. The lower torus of the base of the antæ of the temple of Erechteus is receded, and that of the base of the antæ of the temple of Minerva Polias is channelled with flutes, separated from each other by two small cylindric mouldings of a quadrantal section, having their convexities joining each other. This form of a base is by Vitruvius very properly called the Attic base, being invented and employed by the Athenians in all their Ionics. It was also adopted by the Romans, and seems to have been their most favourite base; for it is not only employed in all the examples of this order at Rome, but most frequently in the Corinthian and Composite orders also. However, the proportions of the Attic base, as employed by the Romans, are different from that employed by the Greeks, the upper torus of the former being always of a less height than the lower one, both tori plain, and the scotia containing a much deeper cavity. The proportion of the bases of the Ionic and Corinthian orders on the Coliseum, the Ionic on the theatre of Marcellus, and that on the temple of Fortuna Virilis at Rome, have nearly that assigned by Vitruvius. The Ionic bases, as employed in the temple of Minerva Polias at Priene, and in that of Apollo Dedymæus near Miletus, consist of a large torus, three pair of astragals, and two scotiæ, inverted in respect of each other. The upper pair of astragals is disposed below the torus, and the scotiæ separate each pair of astragals from each other. In the temple of Minerva Polias an astragal is employed above the torus, separating it from the shaft; the torus itself is formed elliptically, and the under part of it is fluted: it has also a flute cut in the upper part, near to the bead. In the temple of Apollo Dedymæus, the upper torus is of a semicircular section and plain, and each bead of every pair is separated by a narrow fillet. The base of the Asiatic Ionics differs little from that which Vitruvius appropriates to

this order. In the former the scotiæ are inverted, which gives a greater variety in the profile than when both stand in the same position, as in the Vitruvian base. The Ionians, besides the base which they appropriated to this order, sometimes used the Attic base also, as in the temple of Bacchus at Teos. This base seems not only to have been the most favourite one among the ancients, but is likewise so among the moderns. It is not so heavy in the upper part as that denominated Ionic: its contour is pleasing, and its general appearance elegant. In the capitals of the Athenian Ionics, and in that of Minerva Polias at Priene, the lower edge of the canal between the volutes is formed into a graceful curve, bending downward in the middle, and revolving round the spirals which form the volute upon each side. In the temple of Erectheus and Minerva Polias at Athens each volute has two channels, formed by two spiral borders, and a spiral division between them. The border which forms the exterior of the volute, and that which forms the under side of the lower canal, leaves between them a deep recess, or spiral groove, which continually diminishes in its breadth till it is entirely lost on the side of the eye. In the example of the temple of Erectheus, the column is terminated with a fillet and astragal a little below the lower edges of the volutes, and that of Minerva Polias in the same manner with a single fillet; and the colorino or neck of each is charged with beautiful honeysuckles, formed alike in alternate succession, but differing from each other in any two adjacent ones. The upper annular moulding of the column is of a semicircular section, and embellished with a guilloche. The echinus, astragal, and fillet, are common to both Grecian and Roman Ionic capitals, and the echinus is uniformly cut into eggs, surrounded with borders of angular sections, and into tongues between every two borders. The astragal is formed into a row of beads, with two small ones between every two large ones. These mouldings are cut in a similar manner in all the Roman buildings, except the Coliseum, and what relates to the taste of the foliage. In the temple of Bacchus at Teos, the great theatre at Laodicea, and in all the Roman Ionics, the channel connecting the two volutes is not formed with a border on the lower edge, but is terminated with a horizontal line, which falls a tangent to the second revolution of each volute at the commencement of this revolution. The reader will find the description of the volute among the descriptions of the plates. When columns are introduced in the flanks of a building as well as in the front, one of the capitals of each angular column is made to face both the contiguous sides of the building, with two volutes upon each side, projecting the two adjacent volutes, by bending them in a concave curve towards the angle, as in the temple of Bacchus at Teos, of Minerva Polias at Priene, of Erectheus, and that on the Ilyssus at Athens, as also that of the Manly Fortune at Rome. The capitals of all the columns are sometimes made to face the four sides of the abacus alike on each side, as in the temple of Concord at Rome, from which example the Scammozzian capital was formed. The ancients employed this order in temples dedicated to Juno, Bacchus, Diana, and other deities, whose character held a medium between the severe and the effeminate; and the moderns employ it in churches consecrated to female saints in a matronal state; also in courts of justice, seminaries, libraries, and other structures which have a relation to the arts.

Corinthian Order. The invention of this order was attributed to one Callimachus, an Athenian sculptor, who, passing by the tomb of a young lady, observed an acanthus growing up by the sides of a basket, which was covered with a tile and placed upon the tomb, and that the tops of the leaves were bent downwards by the resistance of the tile, took the hint, and executed some columns with foliated capitals, near Corinth, which were made still of a more slender proportion than the Ionic, imitating the figure and delicacy of virgins. Vitruvius mentions that the shafts of Corinthian columns have the same symmetry as the Ionic, and that the difference of the symmetry between the entire columns arises only from the difference of the heights of their capitals, the Ionic being one third, and the Corinthian the whole diameter of the shaft, which, therefore, makes the height of the Corinthian two thirds of a diameter more than that of the Ionic; hence, as he has allowed the Ionic to be eight diameters, the Corinthian will be eight and two thirds.

The sides of the abacus of the Corinthian capital are concave, and moulded on the fronts.

The lower part of the capital consists of two rows of leaves, and each row of eight plants; one of the upper leaves

fronting each side of the abacus, and the stalk of each leaf springing between each two lower leaves. The height of the abacus is one seventh, the upper and lower tiers of leaves each two sevenths, and the branches and volutes, which spring from the stalks between every two leaves in the upper row, the remaining two sevenths of the diameter. The breadth of the capital at the bottom is one, and each diagonal of the abacus two, diameters of the column. Vitruvius makes no mention of obtunding the corners of the abacus, as is generally practised by the ancients as well as the moderns; we are, therefore, led to suppose, that each pair of the four faces of the abacus were continued till they met in an acute angle, at each corner, as in the temple of Vesta at Rome, and the Stoa or portico at Athens; the division of the capital is the same as is frequently used by the moderns, but the entire height thereof is generally made one sixth more than the diameter of the column, and that of the entire column ten diameters. The best ancient specimens of the Corinthian order are to be collected from the Stoa, the arch of Adrian, and that most exquisite and singular specimen, the monument of Lysicrates at Athens; also in the Pantheon of Agrippa, and in the three columns of the Campo Vaccino at Rome; these two, and particularly the last, are allowed to be the most complete existing examples that are to be found in all the remains of antiquity. The taste of the foliage of the Attic Corinthian differs considerably from that of the Roman: the small divisions of the leaves are more pointed, approaching nearer to the acanthus than those at Rome, which are for the most part olive; however, in other respects, the capitals themselves are very similar, except in the monument of Lysicrates.

The Corinthian capital exhibits the utmost degree of elegance, beauty, richness, and delicacy, that has ever been attained in architectural composition, though many attempts have been made to exceed it. The columns of this order do not appear to have had any appropriate entablature in the time of Vitruvius; for, in B. IV. chap. i. he informs us, that both Doric and Ionic entablatures were supported by Corinthian columns, and that it was the columns alone which constituted this order, and not the entablatures; however, in the remains of Grecian and Roman antiquity we find, almost constantly, Corinthian columns supporting an entablature with a peculiar species of cornice; a composition which seems to be borrowed from those of the Doric and Ionic orders. In this entablature the figure of the mutules supporting the corona is changed into the form of a console, and highly decorated; and the denticulated Ionic band, with its cymatium, and also that of the frize, are introduced below the consoles, which in this application are called *modillions*. This disposition is inverting the order of the original hut, and also the description given by Vitruvius. The only example, where dentils are placed above modillions, is in the second cornice of the tower of the Winds at Athens. As to the architrave and base of this order, they may be the same as those used in the Ionic; indeed, the Ionic entablature itself would, on many occasions, be a very appropriate one for the Corinthian. When the columns are fluted, the number of the flutes and fillets is generally 24, as in the Ionic order.

If the entablature be enriched, the shaft should be fluted, unless composed of variegated marble; for a diversity of colours confuses even a smooth surface, and, if decorated, the ornament increases the confusion to a much greater degree. When the columns are within reach, so as to be liable to be damaged, the lower part of the flutes, to about one third of their height, is sometimes filled with cables, as that of the interior order of the Pantheon, with a view to strengthen the edges.

In rich work of some modern buildings, the cables are composed of reeds, husks, spiral twisted ribbands, flowers, and various other ornaments; but these niceties should only be employed in the decorations of the interior, and even then very sparingly, as their cost would be much better employed in giving majesty and grandeur to other parts of the fabric. As the cornice which has obtained the name of Corinthian consists of so many members, it will be necessary on this account to increase the whole height of the entablature more than two diameters, so as to make the members distinct, and at the same time to preserve a just proportion between the cornice, frize, and architrave; making the height of the entablature two-ninths of that of the column; but if the Ionic cornice is to be employed, or the dentils and their cymatium omitted, two diameters, or a fifth of the height of the column will be sufficient. From hence the absurdity of giving too many members to the cornice will appear, as these slight columns are incapable of

bearing an entablature of the same part of their height as columns of fewer diameters are: this absurdity will more readily appear, when the parts of both orders are made of the same altitudes.

The Corinthian order is appropriate for all buildings, in which magnificence, elegance, and gaiety, are requisite; it was employed by the ancients in temples dedicated to Venus, Flora, Proserpine, and also to the nymphs of the fountains, being the most splendid of all the orders, and bearing the most affinity to foliages, flowers, and volutes, which suited the delicacy and elegance of these deities.

Its splendor also recommends it in the decorations of palaces, squares, galleries, theatres, banqueting rooms, and other places consecrated to festive mirth, or convivial recreation; it is likewise employed in churches dedicated to saint Mary, and other virgin saints.

Tuscan order. There are no ancient remains of any entire order of this kind; the columns of Trajan and Antonine, and one at Constantinople, being defective from the want of their entablatures. We have the description of Vitruvius to the following purpose: the column is seven diameters in height, and is diminished at the top a fourth part of a diameter; their bases have a circular plinth, and are in height half a diameter, which is divided into two parts, giving one to the altitude of the plinth, and one to the torus. The capital has also half a diameter in height, and one in the breadth of its abacus. The height of the capital is divided into three parts, one of which is given to the plinth or abacus, one to the echinus, and the third to the hypotrachelian with the apophygis: the architrave is made with its vertical faces over the edge of the column, at the neck of the capital, in two thicknesses, in its horizontal dimension, with a space of two digits or $1\frac{1}{2}$ inch between, for the admission of air, to prevent the beams from rotting, and joined together with mortise and tenon. Over the beams and over the walls the mutules are projected a fourth part of the height of the columns, and antepagments are fixed to their fronts. A correct specimen of Tuscan architecture may be seen in St. Paul's, Covent Garden, the work of the most distinguished Inigo Jones. This order is proper for all rustic structures.

Roman order. The character of this as an order is indicated by its capital; the upper part of which being an entire Ionic capital of that species, which fronts the four sides of the column alike, and the lower part consisting of two rows of leaves, as in the Corinthian capital. Vitruvius speaks of various capitals derived from that of the Corinthian; but does not distinguish columns with such capitals supporting an entablature by the name of an order; indeed, he expressly says that they do not belong to any species of columns. Serlio was the first who added a fifth order, by compounding columns similar to that of the Arch of Titus, with the entablature of the uppermost order of the Coliseum. More recent authors have, for the greater part, either adopted the entablature of the frontispiece of Nero, which was supported by Corinthian columns, or have brought in adventitious parts of other orders, by introducing the denticulated band of the Ionic, with its cymatium between the modillions and the cymatium of the frize. It is something remarkable, that the columns of Roman buildings, with compounded capitals, support, for the greater part, Corinthian entablatures: the columns of the arches of Septimius Severus and of the Goldsmiths support Ionic entablatures; and those of the temple of Bacchus even support an entablature with what we now call a Tuscan cornice. In short, Rome affords no example of a composite order, with a similar cornice to any one found in the works of any distinguished modern author, except Vignola, who crowns his entablature with a bold Ionic cornice. The capital of this order is more bold and massive in its parts than that of the Corinthian; the proportion of the other members should be corresponding thereto, and therefore more appropriate cornice than that of the frontispiece of Nero can hardly be applied: the modillions are very characteristic, but the denticulated band, shewn in a modern work, should be omitted: and for this reason also the shaft of the columns should be a medium between those of the Ionic and Corinthian, though the very reverse has been assigned to it.

The medallions employed in this order differ from the Corinthian; they are more massy, being composed of two faces, and a cymatium like an architrave. The Romans decorated their composite capitals with acanthus leaves, and the same practice is followed by the moderns. The proportions will be fully understood in those of the Ionic and Corinthian orders. It is probable that the Romans employed the Composite order in their triumphal arches, and other buildings, to commemorate their victories, and to shew their domi-

nion over those whom they conquered; and for this purpose also it may be employed in modern structures, to celebrate the achievements of conquerors and virtues of legislators.

PRINCIPLES OF BUILDING,

Are those parts of geometry, mechanics, mensuration, and chemistry, which shew how to design and construct the parts of a building, so as to be the most durable, the destination, situation, and other fixed data of the intended structure, being known. These parts of the sciences are the foundation of the art of construction.

Construction may in general be divided into two parts, the science of masonry, and that of carpentry; though there are other branches, as slatery, plumbery, &c. sometimes also employed as constituent parts; but these may be considered as rather adventitious.

The science of masonry shews how to construct walls and vaults. A wall should be built so as to resist a given force, either acting uniformly over the whole, or partially upon the surface: such as to resist the pressure of vaults or roofs unrestrained from the want of tie beams, acting along one continued butment, as in plain vaulting; or to resist different forces, acting at intermitted points, as in groin vaulting; or to resist the force of the wind, acting uniformly over the whole surface. An arch should be so constructed as to balance itself equally on all parts of the intrados, whether it be of uniform thickness, or to support a given load.

The science of carpentry comprehends the sizing, cutting, disposition, and joining of timbers. By chemistry we are enabled to judge of the quality of materials, such as stone, mortar, wood, iron, slate, lead, &c.

Taste. Taste consists in introducing such forms in the construction and embellishments, as appear agreeable to the eye of the beholder. The arrangement of the plan, figure of rooms, and contour of the whole building, and character, as to its destined purpose, depend much on taste.

Invention. Invention is the art of combining or arranging the various apartments in the most convenient order.

Basements. A basement is the lower story of a building on which an order is placed; its height will therefore be variable, according as it is the cellar story or the ground story; or, when it is the ground story, according as there are principal rooms in both stories, or only in one of them. It is proper, however, to make the basement no higher than the order of the next story; for this would be making the base more principal in the composition than the body to be supported. If the cellar story is the basement, and if the height does not exceed five or six feet at the most, it may be plain, or with rustics, or formed into a continued pedestal; but if the basement is on the ground story, the usual manner of decorating it is with rustics supported on a base, and surmounted with a crowning string-course: the base may either be a plinth alone, or with mouldings over it: in like manner the string-course may either be a platband, or with mouldings under it; or it may form a cornice. The rustics are either made of a rectangular or triangular section, by imagining one of the sides of these sections to be a line extending across the front of the joint. The joints of the rustics may be from an eighth to a tenth part of their height. The depth of the joint of the triangular rustic may be half of its breadth, that is, making the two planes by which it is formed a right angle, and the depth of the rectangular sectioned rustics from one-fourth to one-third of their breadth. The ancients always marked both directions of the joints of the rustics; whereas the moderns not only employ the ancient manner, but they sometimes make them with horizontal joints alone. Those with horizontal joints represent rather a boarded surface than that of a stone wall, which must have two directions of joints. The height of the string-course should not exceed the height of a rustic with its joint: the plinth, or zocholo, ought not to be less than the height of the string-course. When the basement is perforated with arcades, the imposts of the arches may be a platband, which may be equal to the height of a rustic, exclusive of the joint. When the string-course is a cornice, the base may be moulded, and the projection of the cornice may be two-thirds of its height; so as to be less prominent than that which finishes the building. The height of the cornice may be about one-eighteenth part of the height of the basement, and that of the base about twice as much, divided into six parts, of which the lower five-sixths form the plinth, and the upper sixth the mouldings.

Pedestals. A pedestal is a part of some buildings, with a base, surmounted with a rectangular prismatic solid, called the die, and this die again crowned with a cornice, for supporting a colonade, or pilastrade, or sometimes for supporting

the upper part of a building as a basement. In the buildings of the Greeks pedestals never obtained: the columns of their temples generally stood on the uppermost of three steps; indeed, there is no existing example with any other number than three, except the temple of Theseus at Athens, which had only two, and was supposed to have been erected to an inferior deity: whatever innovations took place were after Greece lost its independence. The Romans, in many of their temples and other edifices, raised the floors so very high, that they were under the necessity of discontinuing the front stairs, which otherwise would have been found inconvenient, in occupying too much ground around the edifice; and of adopting a pedestal, or podium, as a basement; which was raised as high as the stair, and projected to the front of the steps which profiled on the sides of the pedestal.

It is remarkable, that Vitruvius, in treating of the Doric, Corinthian, and Tuscan orders, never mentions a pedestal: and in treating of the Ionic, he only speaks of it as a necessary part of the construction, and not as part of the order: several modern writers are also of this opinion.

It must be confessed, wherever pedestals are introduced, the grandeur of the order is diminished, as all the parts are proportionably less; however, there are some situations, in which they are indispensably necessary, as in the interior of churches, where, if they were omitted, the beauty of the columns would be entirely lost, as so great a portion of them would be concealed by the pews. The proportions of pedestals in the ancient Roman buildings are very variable; modern authors, however, have thought proper to bring them to a standard ratio, which Vignola makes one-third of the height of the column; but as this proportion appeared to make them too high, Sir William Chambers reduced it to three-tenths; these ratios, however, might vary as particular circumstances might require. The parts of pedestals may be thus proportioned: divide the height into nine equal parts, give one to the cornice, two to the base, and six to the die. The plan of the die is the same as that of the plinth of the column: the projection of the cornice may be equal to its height: the base may be divided into three parts, giving two to the plinth, and one to the mouldings, which in most cases may project equal to their height. These proportions are common to all pedestals. It is sometimes customary to adorn the dies of pedestals with sunk pannels, surrounded with mouldings: the pannels are frequently charged with bas reliefs or inscriptions. Projecting tablets should never be admitted, as they are not only clumsy, but confuse the contour. The dies of the pedestals of the arches of Septimius Severus and Constantine have straight-headed niches, with statues. Pedestals should never be insulated, though the columns which stand upon them were insulated. In the theatres and amphitheatres of the ancients, pedestals were used in all the superior orders, while the inferior order stood upon steps. They were employed for the purpose of forming a parapet for the spectators to lean over, and for raising the base of the superior order so high, as to be seen upon a near approach to the building. In these situations the pedestals were made no higher than to prevent accidents. When pedestals are continued with breaks under the columns, or pilasters in ancient buildings, the breaks were called stylobatæ; and the recess between every two stylobatæ, the podium, which had the same parts disposed at the same levels as the stylobatæ.

Arcades. An arcade is an aperture in a wall with an arched head; which term is also sometimes applied in the plural number to a range of apertures with arched heads. When an aperture is so large that it cannot be lintelled, it then becomes necessary to arch it over. Arcades are not so magnificent as colonades, but they are stronger, more solid, and less expensive. In arcades the utmost care should be taken of the piers, that they be sufficiently strong to resist the pressure of the arches, particularly those at the extremes. The Romans employed them in their triumphal arches, and many other buildings. Arcades may be used with propriety in the gates of cities, of palaces, of gardens, and of parks; they are much employed in the piazzas or squares of Italian cities; and, in general, are of great use, in affording both shade and shelter in hot and rainy climates; but, on the contrary, they are a great nuisance to the inhabitants, as they darken their apartments, and serve to harbour idle and noisy vagabonds. Lofty arcades may be employed with great propriety in the courts of palaces, and noblemen's houses. There are various ways of decorating the piers of arcades, as with rustics, columns, pilasters, caryatides, persians, or terms surmounted with appropriate entablatures; and sometimes the piers are even so broad, as to admit of niches. The arch is either surrounded with rustic work, or

with an archivolt; sometimes interrupted at the summit with a key-stone, in the form of a console, or marsh, or some other appropriate sculptured ornament. The archivolt rises sometimes from a platband, or impost, placed on the top of the piers; and at other times from an entablature, supported by columns on each side of the arch. In some instances the arches of arcades are supported entirely by single or coupled columns, without the entablature; as in the temple of Faunus at Rome. This form is far from being agreeable to the eye; it wants stability, as the columns would be incapable of resisting the lateral pressure of the arches, were they not placed within another walled enclosure, or in a circular colonade. In large arches the key-stones should never be omitted, and should be carried to the soffit of the architrave, where they will be useful in supporting the middle of the entablature, which otherwise would have too great a bearing.

When columns are detached, as in the triumphal arches of Septimius Severus and Constantine, at Rome, it becomes necessary to break the entablature, making its projection over the intercolumns the same as if pilasters had been used instead of columns; or so much as is just sufficient to relieve it from the nakedness of the wall. This is necessary in all intercolumns of great width, but should be practised as little as possible, as it destroys the genuine use of the entablature. When columns are without pedestals, they should stand upon a plinth, in order to keep the bases dry and clean, and prevent them from being broken.

Arcades should never be much more, nor much less, than double their breadth. The breadth of the pier should seldom exceed two-thirds, nor be less than one-third, of that of the arcade; and the angular pier should have an addition of a third, or a half, as the nature of the design may require. The impost should not be more than one-seventh, nor less than a ninth, of the breadth of the arch; and the archivolt not more than one-eighth, nor less than one-tenth, of that breadth. The breadth of the bottom of the key-stone should be equal to that of the archivolt; and its length not less than one and a half of its bottom breadth, nor more than double. In groined porticos, the thickness of the piers depends on the width of the portico, and the superincumbent building; but with respect to the beauty of the building, it should not be less than one quarter, nor more than one-third, of the breadth of the arcade. When the arcades form blank recesses, the backs of which are pierced with doors or windows, or recessed with niches, the recesses should be at least so deep, as to keep the most prominent parts of the dressings entirely within their surface. In the upper stories of the theatres and amphitheatres of the Romans, the arcades stood upon the podia, or inner-pedestals, of the columns; perhaps as much for the purpose of proportioning the apertures, as to form a proper parapet for leaning over.

Colonades. A colonade is a range of attached or insulated columns, supporting an entablature. The interval between the columns, measured by the inferior diameter of the column, is called the intercolumniation; and the whole area between every two columns is called an intercolumn. When the intercolumniation is one diameter and a half, it is called pycnostile, or columns thick set; when two diameters, systyle; when two and a quarter, eustyle; when three, diastyle; and when four, aræostyle, or columns thin set. A colonade is also named according to the number of columns which support the entablature, or fastigium: when there are four columns, it is called tetrastyle; when six, hexastyle; when eight, octostyle; and when ten, decastyle. The intercolumniations of the Doric order are regulated by the number of triglyphs, placing one over every intermediate column: when there is one triglyph over the interval, it is called monotriglyph; when there are two, it is called ditriglyph; and so on, according to the progressive order of the Greek numerals. The intercolumniation of the Grecian Doric is almost constantly the monotriglyph: from this practice there are only two deviations to be met with at Athens, the one in the Doric Portico, and the other in the Propylæa; but these intervals only belong to the middle intercolumniations, which are both ditriglyph, and became necessary, on account of their being opposite to the principal entrances. As the character of the Grecian Doric is more massy and dignified than that of the Roman, the monotriglyphic succeeds best; but in the Roman it is not so convenient, for the passage through the intercolumns would be too narrow, particularly in small buildings, the ditriglyph is therefore more generally adopted. The aræostyle is only applied to rustic structures of Tuscan intercolumniations, where the

columns are lintelled with wooden architraves.

When the solid part of the masonry of a range of arcades are decorated with the orders, the intercolumns become necessarily wide; and the intercolumniation is regulated by the breadth of the arcades, and that of the piers.

It does not appear that coupled, grouped, or clustered columns, ever obtained in the works of the ancients; though, on many occasions, they would have been much more useful: we indeed find, in the temple of Bacchus at Rome, columns standing as it were in pairs; but as each pair is only placed in the thickness of the wall, and not in the front, they may rather be said to be two rows of columns, one almost immediately behind the other. In the baths of Dioclesian, and in the temple of Peace at Rome, we find groined ceilings, sustained by single Corinthian columns; a support both meagre and inadequate. Vignola uses the same intercolumniation in all his orders: this practice, though condemned by some, is founded upon a good principle; it preserves a constant ratio between the columns and the intervals.

Of all the kinds of intercolumniation, the custyle was in the most general request among the ancients; and though in modern architecture both the custyle and diastyle are employed, yet the former of these is still preferred in most cases: as to the pycnostyle interval, it is frequently rejected for want of room, and the aræostyle, for want of giving sufficient support to the entablature.

The moderns seldom employ more than one row of columns, either in external or internal colonades; for the back range destroys the perspective regularity of the front range: the visual rays, coming from both ranges, produce nothing but confusion in the eye of the spectator. This confusion, in a certain degree, also attends pilasters placed behind a row of insulated columns; but in this the relief is stronger, owing to the rotundity of the column, and the flat surfaces of the pilasters. When buildings are executed on a small scale, as is frequently the case of temples, and of other inventions used for the ornaments of gardens, it will be found necessary to make the intercolumniations, or at least the central one, broader than usual, in proportion to the diameter of the columns; for, when the columns are placed nearer each other than three feet, the space becomes too narrow to admit persons of a corpulent habit.

Pilasters and Antæ. Pilasters are rectangular prismatic projections, advancing from the naked part of a wall, with bases and capitals like columns, and with an entablature supported by the columns; hence they differ from columns in their horizontal sections being rectangles, whereas those of columns are circles, or the segments of circles, equal to, or greater, than semicircles.

It is probable that pilasters are of a Roman invention, since there are but few instances in Grecian buildings where they are repeated at equal or regular intervals, and these only in the latter ages of Greece, as in the monument of Philopapus, (unless in that of Thrasyllus); but of their application in Roman works there are numberless instances: Vitruvius calls them parastatæ. The Greeks used a kind of square pillars only upon the ends of their walls, which they called antæ, which antæ projected sometimes to a considerable distance from the wall of the principal front, and formed the pronaos or vestibulum. The breadth of the antæ on the flanks of the temples was always considerably less than on the front: these antæ had sometimes columns between them, and when this was the case, the return within the pronaos was of equal breadth to the front. The capitals of the antæ never correspond with those of columns, though there are always some characteristic marks, by which the order may be distinguished.

Pilasters, or parastatæ, when ranged with columns under the same entablature, or placed behind a row of columns, have their bases and capitals like those of the columns, with the corresponding parts at the same heights, and when placed upon the angles of buildings, the breadth of the returns is the same as that of the front. The trunks of pilasters have frequently the same diminution as the shafts of the columns, such as in the arches of Septimius Severus and Constantine, and in the frontispiece of Nero, and the temple of Mars the Avenger, at Rome; in this case, the top of the trunks of the pilasters is equal to the breadth of the soffit of the architrave, and the upright face of the architrave resting on the capital, in the same perpendicular as the top of the pilaster. When the pilasters are undiminished, and of the same breadth as the columns at the bottom, the face of the architrave resting on the capital retreats within the top of the trunk, as in the Pantheon of Agrippa.

Pilasters are either plain or fluted. In

ancient edifices this was not always regulated by the columns, but perhaps depended on the taste of the architects, or destination of the edifice. The columns are plane on the portico of the Pantheon, while the pilasters are fluted; and the contrary, on the portico of Septimius Severus. When pilasters are fluted, the angles or quoins are frequently beaded, such as those of the pantheon, in order to strengthen the angles, and the flutes are generally of a semicircular section. The faces of pilasters are sometimes sunk within a margin, and the pannels charged with foliage, arabesque or grotesque ornaments, or instruments of music and war, or sometimes these compounded, according to the destined purpose of the place in which they are employed.

The pannels of the pilasters, in the Arch of the Goldsmiths at Rome, are charged with winding foliage and trophies of war. Pilasters, when placed on the front or outside of a building, should project one quarter of their breadth at the bottom; but when placed behind a range of columns, or in the interior of a building, should not project more than the eighth part of the same breadth.

In a large recess, when two or any even number of insulated columns support an entablature, which terminates at each end upon a wall or pier, a pilaster is most commonly placed against each wall or pier, to support the extremities of the architrave. When the entablature over the columns is recessed within the surface of the wall or pier at each end, the pilaster projects towards the column, its thickness is shewn on the front, and its breadth faces the void or adjacent column: in this case the architrave may either profile against the sides of the aperture or recess, or it may return at each interior angle, and then again at the exterior angles, and proceed along each wall or pier.

If the intermediate columns and extreme pilasters are so ranged as to project a small distance beyond the face of the wall at each end, the pilasters shew the same breadth towards the front as towards the void, and the entablature may be continued unbroken, as in the chapels of the Pantheon; and if it breaks, it must be at the extreme or most distant angles. Pilasters are of great strength to a wall, as well as ornamental to the building; they are less expensive than columns, and in situations where they are either placed behind a range of columns, or support the extremes of an entablature across an opening, they are more concordant with the walls to which they are attached.

Clustered pilasters, or those which have both exterior and interior angles, and the planes of those angles parallel and perpendicular to the front, may be executed with good effect, when the order is plain, as in the Tuscan: but in the three Grecian and Composite orders, this junction should be avoided as much as possible, because the triglyphs and capitals of these orders always meet imperfectly in the interior angles. The same may also be said of Ionic and Corinthian capitals of half pilasters, meeting each other in the interior angles of rooms. In the Ionic order it becomes necessary to make a difference between the capitals of pilasters and those of columns; for in the capitals of the columns the projection of the ovolo is greater than that of the volutes; but as the horizontal section of the ovolo is circular, the ovolo itself is bent behind the hem or border of the volutes: now, supposing a vertical section through the axis of the column to be perpendicular to the face, and another through the middle of the breadth of the pilaster, and that the corresponding mouldings are equal and similar in both section; then, because the horizontal section, through the ovolo, is rectangular, as in the trunk, the ovolo would, if continued, pass over the volutes, or must terminate abruptly, and shew the profile of the moulding, which is a palpable defect. This therefore renders it necessary to give the ovolo so much convexity on the front, as to make its extremes retire, and pass behind the back of the border of the volutes; or to make the ovolo of small projection; or to twist the volutes from a plain surface, which the ancient Ionic has, and make every part of the spirals project more and more towards the eye; or, lastly, to project the whole abacus, with the volutes, beyond the projection of the ovolo. The same thing is also to be observed with regard to the Corinthian and Composite capitals, where the upper part of the vase projects beyond the middle of the abacus, and would, in the pilaster capitals, pass over the face of the spirals or volutes.

Persians and Caryatides. Instead of columns, or pilasters, it is sometimes customary to support the entablature by human figures: the males of which are called Persians, Talamones, or Atlantides; and the females, Carians, or Cayratides. The history of these Vitruvius relates as follows: "Caria, a city of Peloponnesus,

having joined with the Persians against the Grecian states, and the Greeks having put an end to the war, by a glorious victory, with one consent declared war against the Caryatides. They took the city, destroyed it, slew the men, and led the matrons into captivity, not permitting them to wear the habits and ornaments of their sex; and they were not only led in triumph, but were loaded with scorn, and kept in continual servitude; thus suffering for the crimes of their city. The architects therefore of those days introduced their effigies sustaining weights, in the public buildings, that the remembrance of the crime of the Caryatides might be transmitted to posterity. The Lacedæmonians, likewise, under the command of Pausanias, the son of Cleombrotus, having at the battle of Platea, with a small number, vanquished a numerous army of Persians, to solemnize the triumph, erected with the spoils and plunder the Persian Portico, as a trophy, to transmit to posterity the valour and honour of the citizens; introducing therein the statues of the captives, adorned with habits in the barbarian manner, supporting the roof."

There can be little doubt but that human figures, and those of inferior animals, had a very early introduction in architecture, and are of more remote antiquity than that assigned by Vitruvius; for we are informed by Diodorus Siculus, that in the sepulchre of Osymanduas there was a stone hall four hundred feet square, the roof of which was supported by animals instead of pillars: the number of these supports is not mentioned. The roofs of several Indian buildings, supposed of the most remote antiquity, are sustained in the same manner. In Denon's travels in Egypt, among other fragments, are represented five insulated pilasters or pillars, bearing an entablature: the fronts of the pillars are decorated with priests or divinities. The molten sea, recorded in Holy Writ, was supported by twelve bulls. In the Odyssey of Homer, translated by Pope (book vii. ver. 118,) we find the effigies of animals, both rational and irrational, employed as decorations, which appears by the following extract.

Two rows of stately *dogs*, on either hand,
In sculptur'd gold and labour'd silver stand.
These Vulcan form'd with art divine, to wait,
Immortal guardians, at Alcinous' gate.
Alive each animated frame appears,
And still to live beyond the power of years.
Fair thrones within from space to space were rais'd,
Where various carpets with embroidery blaz'd,
The work of matrons: these the princess prest,
Day following day, a long continued feast,
Refulgent pedestals the walls surround,
Which *boys* of gold with flaming torches crown'd.

However, these representations of animals were not employed as columns to support an entablature, but merely as ornaments.

In Stewart's antiquities of Athens, we find a most beautiful specimen of Caryatic figures supporting an entablature, consisting of an architrave cornice of a very elegant profile. Among the Roman antiquities, there are likewise to be found various fragments of male figures, which may be conjectured, from their attitudes and ornaments, to have been the supports of the entablatures of buildings.

Besides Persians and Caryatides, it is sometimes customary to support the entablatures with figures, of which the upper part is the head and breast of the human body, and the lower part an inverted frustrum of a square pyramid, with the feet sometimes projecting out below, as if the body had been partly cased: figures of this form are called terms or termini, which owe their origin to the stones used by the ancients in marking out the limits of property belonging to individuals. Numa Pompilius, in order to render these boundaries sacred, converted the Terminus into a deity, and built a temple on the Tarpeian Mount, which was dedicated to him, whom he represented by a stone, which, in course of time, was sculptured into the form of a human head and shoulders, and other parts, as has already been defined. He was on particular occasions adorned with garlands, with which he appeared of a very pleasant figure. Persian figures are generally charged with a Doric entablature; Caryatic figures with Ionic or Corinthian, or with an Ionic architrave cornice; and the Termini with an entablature of any of the three Grecian orders, according as they themselves are decorated. Male figures may be introduced with propriety in arsenals or galleries of armour; in guard rooms, and other military places, where they might repre-

sent the figures of captives, or else of martial virtues, such as Strength, Valour, Wisdom, Prudence, Fortitude, and the like. As these figures should be of a striking character, they may be of any colossal size that will agree with the architecture of the other parts of the buildings. In composing Caryatides, the most graceful attitudes and pleasant features should be chosen: and, to prevent stiffness, their drapery and features should be varied from each other, in the different figures of the range; yet a general form of figure should be preserved throughout the whole of them.

Caryatides should always be of a moderate size, otherwise they might appear hideous to the fair sex, and destroy those endearments so fascinating in the sex represented by them. They may be employed, as Le Clerc observes, to sustain the covering of a throne, and represented under the figures and symbols of heroic virtues: if to adorn a sacred building, they must have an affinity to religion; and, when placed in banqueting rooms, ball rooms, or other apartments of recreation, they should be of kinds proper to inspire mirth and promote festivity. As Termini are susceptible of a variety of decorations, they may be employed as embellishments for gardens and fields, representing Jupiter as protector of boundaries, or some of the rural deities, as Pan, Flora, Pomona, Vertumnus, Ceres, Priapus, Faunus, Sylvanus, Nymphs, and Satyrs.

They are also much employed in chimney-pieces, and other interior compositions.

Orders above Orders. When two or more orders are placed one above the other, the laws of solidity require that the strongest should be placed lowermost; and also, that their axes should be in the same vertical lines. When the columns of the orders are of the same diameter, their altitudes increase from the Tuscan, Doric, and Ionic, to the Corinthian; and, consequently, in this progression, the Tuscan is stronger than the Doric, the Doric stronger than the Ionic, and the Ionic stronger than the Corinthian: therefore, if the Doric be the lowest order, the Ionic is the succeeding order; and if there be a third order, the Corinthian is in consequence the next. But since the different stories of a building should rather be of a decreasing progression upwards, than even of an equal altitude to each other, it follows that the superior columns should not only be diminished, in order to lessen the insisting weight from the inferior, but also to accommodate the heights of windows.

The rule given by Vitruvius (b. v. c. 7.) for placing one order above another, is, to make the columns of the superior order a fourth part less in height than those of the inferior.

Scamozzi's rule is, to make the diameter at the bottom of the shaft of the superior order equal to the upper diameter of the inferior order.

Let us now suppose that the Ionic of nine diameters is to be raised upon the Doric of eight diameters, as in the Roman Doric; according to the rule given by Vitruvius, the bottom diameter of the Ionic will be two-thirds of that of the Doric, a quantity much less than is to be found in any ancient or modern examples of the diminution of the Doric shaft; which diminution is the lower diameter of the superior order, by Scamozzi's rule.

In insulated columns, when the diminution of the superior order is very great, the intercolumn becomes so wide, and the entablature so small, and consequently weaker, that it is in danger of breaking; and if a third range is added, this defect must be increased. The Vitruvian rule is therefore not so applicable as the Scamozzian, which, for the above reasons, is universally esteemed the best, and is the same as if the several shafts had been cut out from one long tapering tree; on the other hand, when the diminution of the inferior diameter of the superior order is too little, or nothing, the columns will not only be too high for the windows, but the lower order will be loaded with unnecessary weight. Let the stronger order be made the superior; for example, let the Doric be placed upon the Ionic, and allowing the shaft of it to diminish five-sixths of its bottom diameter, the height of the Doric column will be only 6 2-3ds diameters of the Ionic below: this would not only make a complete Attic of the Doric, but would render the application of the orders in this inverted way useless, as they could not be made to accommodate the stories of the building, nor could the upper ranges support their own entablatures, which must be the consequence in insulated columns.

When the front of a building is to have two or more orders in the altitude, the succession ought to be complete, otherwise the harmony will be destroyed by the violent contrast of the parts. When columns are attached, a recedure of the superior order will not offend the eye in any great degree, nor will the solidity of the struc-

ture be impaired; this is to be seen in the theatre of Marcellus; but when the stories of orders are insulated, it is necessary that the axis of the superior and inferior columns should be in the same vertical lines. If the upper order only insists in the middle of that below in two equidistant parts from the middle, the portions of the entablature of the lower order, in which there is no superior order, are generally finished with a ballustrade, level with the sills of the windows.

In England we have few examples of more than two ranges of columns in the same front; for when there are three, it is difficult to preserve the character of each order in the intercolumnial decorations, without some striking defects. The first and second orders should stand upon a plinth, and the third also, when there is one, the point of view regulating the two upper plinths. In this case pedestals should be omitted in the upper orders, and if there is one, or a ballustrade under the windows, the base and cornice should have but a small projection, and should be continued to profile upon the sides of the columns. In raising the stories of arcades upon each other, with orders decorating the piers, the inferior columns should be placed upon a plinth, and the superior ones upon a pedestal, in order that the arches may obtain a just proportion.

Pediments. A pediment is a part of a building having a horizontal cornice below, and two equally inclined ones, or an arched cornice, above, joined at the extremities of the horizontal one; the cornices including a plane surface within, called the tympanum, which is therefore either a triangle or the segment of a circle.

This definition does not comprehend every species of pediments which have been absurdly introduced; but it may be said to be the only genuine one, as pediments represent the ends of roofs, and were originally intended to discharge the rain from the middle of the building, by compelling it to descend and fall over the flanks or extremes, and not over the front, which must be the case with every other figure that can be introduced, except those of a polygonal form, which present their interior angles to the horizontal cornice, or the exterior ones upwards. To find the pitch of the pediment Vitruvius directs as follows: divide between the extremities of the cymatium of the corona into nine equal parts, and one makes the height of the tympanum; but this rule is not correct, as the tympanum will vary its angles according as there are more or less mouldings of the inclined cornices within the extremities of the cymatium of the corona; for since the middle part by this rule is invariable, and the broader the parts are of the inclined cornices within each extremity of the cymatium of the corona, or rather within the under edge of the fillet of the syma upon each inclined cornice, the less is the base of the tympanum, and consequently the vertical angle less obtuse, and the base angles less acute; but if this height extended to the meeting of the two under sides of the fillets of the syma, or crowning moulding, then the figure of the tympanum would be invariable. The Vitruvian rule has been thought by many to be too low; but it is to be recollected, that that of the Parthenon at Athens, which has an octostyle portico, is nearly of this proportion; that of the temple of Theseus, which has an hexastyle portico, is about one-eighth; that of the Ionic temple on the Ilyssus, and of the Doric portico, which are both tetrastyle, are about one-seventh; the tympanum of the pediment of the door on the Tower of the Winds is about one-fifth of the span. The edifices here mentioned are all Athenian buildings. From this comparison it would appear, that a kind of reciprocal ratio subsists between the extension of the base of the tympanum and its height. Indeed, if a fixed ratio were applied to windows, the pediment would frequently consist of a cornice, without the tympanum. It is therefore with great reason that we often make the pitch of pediments of windows more than those which crown porticos, or the fronts of buildings. The plinths by which pediments are sometimes decorated are called acroterions, or acroters: the two which present triangular faces at the extremes have their heights, according to Vitruvius, half of that of the tympanum, and the middle one saddled on the summit is one-eighth part higher than those at the extremes. Pediments owe their origin most probably to the inclined roofs of primitive huts. Among the Romans they were only used as coverings to their sacred buildings, till Cæsar obtained leave to cover his house with a pointed roof, after the manner of temples. In Grecian antiquity we meet only with triangular pediments, and in Roman buildings we meet with both the triangular and circular. In rows of openings, or niches, both kinds of pediments were employed in the same range, and disposed in alternate succession. The horizontal cornices of pediments should never be discontinu-

ed, as may be seen in many of the street houses of London, in order to give room for a fan light, and to lessen the expenses of the frontispiece, by introducing shorter columns and a less massy entablature: for since the horizontal cornice represents the tie-beam, and the inclined ones the rafters, the columns will appear to have a tottering effect, by spreading them out at the top beyond the extremities of their bases.

Vitruvius observes, that the Greeks never used mutules, modillions, or dentils, in the front, in which the end of the roof, or fastigium, appears, because that the ends of the rafters and the ends of the laths which support the tiles only appear at the eaves of the building. Now, as mutules and dentils originated from the projecting ends of the rafters and laths, following the course of nature, it would have been absurd to introduce them into the pediment.

However just this reasoning appears, we find, from the remains of Grecian antiquity, this assertion only verified in the inclined cornices of the pediment: for mutules are constantly employed in the horizontal cornice; but neither mutules, modillions, nor dentils, on the sloping sides: at least, when any of the edifices in Greece appear with those innovations, they are introduced during the time it was a province of the Roman empire. Of this practice at Rome, the Pantheon and the frontispiece of Nero are examples of modillions; and the temple of Fortune one where dentils are used. In the inclined cornices of pediments the sides of the modillions and dentils are planes, perpendicular to the horizon and to the front of the edifice; and in the same vertical planes with those of the modillions or dentils of the horizontal cornice.

Balustrades. A balustrade is a range of small columns, called balusters, supporting a cornice, used as a parapet, or as a screen to conceal the whole or a part of the roof: it is also sometimes used as a decoration for terminating the building. Balustrades are employed in parapets on the margins of stairs, or before windows, or to inclose terraces or other elevated places of resort, or on the sides of the passage way of bridges. It is remarkable, that there are no remains of balusters to be seen in any ancient building. In the theatres and amphitheatres of the Romans, the pedestals of the upper orders were always continued through the arcades, to serve as a parapet for the spectators to lean over. The lowermost seats next to the arena in the ampitheatres, and those next to the orchestra in the theatres were guarded by a parapet, or podium. The walls of ancient buildings generally terminated with the cornice itself, or with a blocking course, or with an Attic. In the monument of Lysicrates at Athens, which is a small beautiful building, the top is finished with fynials, composed of honeysuckles, solid behind, and open between each pair of fynials: each plant or fynial is bordered with a curved head, and the bottom of each interval with an inverted curve. Perhaps terminations of this nature might have been employed in many other Grecian buildings, as some coins seem to indicate; but this is the only existing example of the kind. The temples in Greece are mostly finished with the cornice itself. This was also the case with many of the Roman temples; but as there are no remains of balustrades in ancient buildings, their antiquity may be doubted: they are, however, represented in the works of the earliest Italian writers, who perhaps may have seen them in the ruins of Roman edifices. When a balustrade finishes a building, and crowns an order, its height should be proportioned to the architecture it accompanies, making it never more than four-fifths, nor less than two-thirds, of the height of the order, without reckoning the zocholo, or plinth, on which it is raised, as the balustrade itself should be completely seen at a proper point of view. Balustrades that are designed for use should always be of the height of parapet walls, as they answer the same purpose, being nothing else than an ornamental parapet. This height should not exceed three feet and a half, nor be less than three feet. In the balusters, the plinth of the base, the most prominent part of the swell, and the abacus of their capital, are generally in the same straight line; their distance should not exceed half the breadth of the abacus or plinths, nor be less than one-third of this measure. On stairs or inclined planes the same proportions are to be observed as on horizontal ones. It was formerly customary to make the mouldings of the balusters follow the inclination of the plane; but this is difficult to execute, and, when done, not very pleasant to the eye: though in ornamental iron-work, where it is confined to a general surface, passing perpendicularly by the ends of the steps, it has a very handsome appearance. The breadth of pedestals, when placed over an order, is regulated by the top of the

shafts, the die being always equal thereto. When balustrades are placed upon the entablature of an order, over the intercolumns or interpilasters, and the base and cornice of the balustrade continued, so as to break out and form pedestals over the columns or pilasters, the breadth of the die of the pedestals should be equal to the breadth of the top of the shafts; and where there is no order, the breadth of the die is never more than its height, and very seldom narrower; and the dies of the pedestals are frequently flanked with half dies, particularly when the range of balusters is long. This is not only apparently necessary, but is in reality useful in shortening the range, and forming a better support for the ends of the rail.

Attics. An Attic is a part of a building standing on the cornice, similar in form to that of a pedestal; and is either broken or continued. The use of an attic is to conceal the roof, and to give greater dignity to the design. The Romans employed attics in their edifices, as may be seen in the remains of the triumphal arches, and piazza of Nerva. In the arch of Constantine, pedestals are raised over the columns as high as the base of the attic, and these pedestals are again surmounted with insulated statues. In the ruins of Athens there are no attics to be found: there is one, however, over a Corinthian colonade at Thessalonica, with breaks forming dwarf pilasters over the columns; and with statues placed in front of the pilasters, as in the arch of Constantine. The attic carried round the two courts of the great temple of Balbec is also broken into dwarf pillasters over the columns and pilasters of the order; and the dwarf pilasters have blocking courses over them, on which statues are supposed to have been placed. Attics are very disproportional in the ruins of these ancient edifices, some of them being nearly one-half of the height of the order. The moderns make their height equal to that of the entablature; as to the proportion of the height of the members it may be the same as that for pedestals.

Doors. Doors are apertures in exterior walls, used for passage into public and private buildings; and in the interior, for communication from one apartment to another. In the fourth book of Vitruvius rules are laid down for Doric, Ionic, and Attic doors, all of which have apertures narrower at the top than at the bottom. These trapazoidal closures of apertures have the property of shutting themselves, which, perhaps, might have occasioned the introduction of this form, and are useful in modern times for raising the door above the floor in the act of opening, in order to keep it clear of the carpet. Examples of them are to be found among the ruins of ancient edifices; they have also been introduced by a few modern architects. The apertures of doors of small dimensions are most commonly closed with lintels. Doors, in general, are regulated in their apertures by the size of a man, so as never to be smaller than that he might pass freely through them; they are seldom less than two feet nine inches in width, by six feet six inches in height, except in confined situations, and where utility is beyond any other consideration.

Doors of entrance vary in their dimensions, according to the height of the story, or magnitude of the building, in which they are placed. In small private houses four feet may be the greatest width, and in most cases three feet six inches will be sufficient. The lintels of doors should range with those of the windows; and the width of their aperture should not be less than that of the windows. A good proportion of doors is, that where its dimensions has the ratio of three to seven; their height should never be less than twice, nor more than twice and a half, their breadth. In the entrance doors of public edifices, where there is a frequent ingress and egress of people, and often crowded, their width may be from six to ten feet. Inside doors, or doors of communication, should be in some measure proportioned to the height of the stories; however, there is a certain limit for the dimensions of their apertures, which they should not exceed; for the difficulty of shutting the door will be increased by its magnitude; therefore the apertures of doors, which are intended to shut in one breadth, should never exceed three feet six inches. In palaces and in noblemen's houses, where much company resort, and in state apartments, all the doors are frequently thrown open; they are made much larger than other doors, being from four to six feet in width, with folding leaves. The proportion of the apertures of such doors will often be of a less height than that of twice the breadth, as all the rooms in the same story have a communication with one another, the whole of the doors in that story will have one common height.

The apertures of exterior doors placed in blank arcades are regulated by the imposts, the top of the aperture being

generally made level with the springing of the arch; or if the door has dressings which include a cornice, the top of the cornice ought to be on the same level with the springing of the arch. With regard to the situation of the principal entrance, it is evident that the door should be in the middle, as it is not only more symmetrical, but will communicate more easily with all the parts of the building. In principal rooms, doors of communication should at least be two feet distant from the walls, if possible, that furniture may be placed close to the door-side of the room. The most common method of adorning doors is with an architrave surrounding the sides of the aperture, or with the architrave surmounted with a cornice, forming an architrave cornice, or with the architrave frize and cornice forming a complete entablature. Sometimes the ends of the cornice are supported with consoles, placed one on each side of the architrave; and each console is most commonly attached to the head of a pilaster; sometimes the surrounding architrave is flanked with pilasters of the orders, or of some other analogical form. In this case, the projections of their bases and capitals are always within that of the architrave: the architrave over the capitals of the pilasters is the same as that of the head of the door, and the parts exactly of the same height, and projections profiling upon the sides of the surrounding architrave. Sometimes, either with or without these dressings, the door is also adorned with one of the five orders, or with columns supporting a regular entablature, frequently surmounted with a pediment. Doors are also sometimes adorned with rustics, which may either be smooth, hatched, frosted, or vermiculated; but their outline must be sharp. The rustics are disposed in contiguity with each other, or are repeated by equal intervals: as to the shafts of columns, the rustic cinctures may either be cylindrical or with rectangular faces. In doors with rectangular apertures and rusticated heads, the rustics are drawn from the vertex of an equilateral triangle within the aperture. The entrance doors of grand houses are often adorned with porticos, frequently in the manner of Grecian temples; sometimes the plan of the portico may be circular, which should never have less than three intercolumniations, as the entablature would appear to overhang its base, in such a degree as to offend the eye of a beholder.

Windows A window is an aperture in a wall for the admission of light. The size of windows depends on the climate, the aspect, the cubature, the proportion, the destination, and the thickness of the walls of the place to be lighted: as also on the number and distribution of windows in that place. It is not very easy, even with these data, to determine, with mathematical exactness, the necessary quantity of light; but in private houses, where beauty and proportion are required, the width of the windows depends on the height of the principal story; otherwise the apertures will be disproportionate figures of themselves, and also to the whole facade in which they are placed.

The apertures of windows should not only be of shapely figures, and proportioned to the building, but the piers also should, in some measure, be regulated by the breadth of the apertures; at least, certain proportionable limits of this breadth ought to be assigned to that of the piers, so as not to offend the eye by their being too clumsy or too small, and at the same time permit a less or greater quantity of light, for a greater or less depth of rooms. As to the size of the piers, considerable latitude may be taken; but in general, they should not be of less breadth than the apertures, nor more than twice that breadth. In a small building, with only three rooms and three windows in the length, the piers will necessarily be large.

In buildings with a great number of windows in the length, where there are at least three windows in one or more principal rooms; and where there are no breaks, the breadths of the piers may be from once the breadth of the window to once and a half that breadth; but if there are columns, pilasters, or breaks, the breadth of the pier may be from once to twice that of the apertures, according as the breadth of the pilasters or columns may require, so as to leave a proper repose of walls upon the sides.

The sills of windows should be from three feet to three feet six inches distant from the level of the floor, forming a parapet for leaning upon: these limits are the natural heights of the breasts of windows; but it is now common, even in ordinary buildings, to make them from two feet to two feet six inches high only. In noblemen's houses the sills are frequently upon the same level with the floor, and sometimes rise a step or two higher. These circumstances will alter the proportion of the windows, and make them

much higher than the double square. The width of all the windows must be the same in the same facade; but the different heights of the stories will require different heights of windows. Were it required to find the quantity of light for a room of given dimensions, it is evident that this will depend upon the area of the inlet and the cubature of the room; therefore, supposing that an aperture containing 20 square feet is sufficient for a room 12 feet square and 10 feet high, that is 1400 cubic feet, the quantity of light will easily be ascertained for a room of any other given dimensions. Let a room be supposed 25 feet long, 20 feet broad, and 14 feet high, the cubature will be seven thousand feet; then, because the cubature of rooms should be as the area of the inlets, the proportion will stand thus:

```
1440 : 7000 : : 20
              20
1440) 140000 (97 the area of the
      12960      inlet required.
       10400
       10080
         320
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Or, instead of working the proposition, divide the cubature of the room by 72, thus:

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72) 7000 (97 as before.
    648
     520
     504
      16
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This quotient, divided into three parts, gives nearly 32 feet for each window, which is very sufficient for light; and after deducting 12 feet, the breadth of three windows, 13 feet will remain for the four piers, which is a very good proportion: there is also abundant room left for any kind of furnishing above the windows.

An odd number of windows, either in the same length of front, or in the same length of principal rooms, is always to be preferred to an even number; for, since it is necessary to have the door in the middle of the front, an even number of windows would occasion a pier to be above the opening of the door, contrary either to regularity, or to the laws of solidity; and in rooms nothing is more gloomy than a pier opposite the centre of the floor. Windows placed in blank arcades should have the under sides of their lintels in the same horizontal plane with the springing of the arch; or if the windows have a cornice, the springing of the arch ought to be carried as high as the top of the cornice.

The aperture of the windows may be from two-fifths to three-fourths of the breadth of the arcade. In the principal floor, the windows are generally ornamented; the most simple kind of which is, that with an architrave, surrounding the jambs and lintels of the aperture, and crowned with a frize and cornice. In cases where the aperture is high, in order to make the dressing of a good composition, the sides of the architrave are frequently flanked with pilasters or consoles, or with both; and sometimes with columns, when there is a set-off or proper base, so as not to have a false bearing. When the principal rooms are in the one pair of stairs, the windows of the ground floor are sometimes left entirely plain, and at other times they are surrounded with an architrave; or the rusticated basement, where there is one, terminates upon their margins without any other finish. The windows in the third story are frequently plain, and sometimes surrounded with an architrave. When the windows in the principal story have pediments, the windows of the story immediately above have frequently their surrounding architraves crowned with a frize and cornice. The sills of all the windows in the same floor should be upon the same level. The sills of the windows in the ground story should be elevated 5 or 6 feet at the least above the pavement. In the exterior of every building the same kind of finish or character should be preserved throughout the same story. Mixtures of windows should be avoided as much as possible; or, where there is a necessity for introducing Venetian windows, they ought to stand by themselves as in breaks.

Gates. A gate is an aperture in a wall, which serves for the passage of horsemen and carriages. They are employed as inlets to cities, fortresses, parks, gardens, palaces, and all places to which there is a frequent resort of carriages. In gates which are closed at the top, the apertures being always wide, are generally made with arched heads: the usual proportion of the arcade is that which has its height double to its breadth, or a trifle more.

The usual ornaments of gates are rustics of several kinds, such as columns, pilasters, entablatures, pediments, attics, blocking courses, imposts, archivolts,

consoles, masks, niches, &c. In gates which are not closed at the top, the breadth of the piers may be from two-fifths to a quarter of their height, reckoning from the bottom of the plinth to the top of the cornice.

The rustics may either be plain, frosted, or vermiculated. The smallest width that can be given to the aperture of a gate is nine feet, which is but just sufficient for the free passage of coaches: but if waggons and loaded carts are to pass, it must not be less than ten or eleven feet; and if the gate is for the entrance of a city, it should not be of a less width than eighteen or twenty feet. The composition of gates should be characteristic of the place to which they are to open. Gates of cities and fortresses should have the appearance of strength and majesty; their parts should be large, few in number, and of bold relief. The same ought likewise to be observed in the gates of parks, public walks, or gardens; these succeed better when composed of rustic work and of the massive orders, than when they are enriched with nice ornaments or delicate profiles. However, triumphal arches, entrances to palaces, to magnificent villas, town or country houses, might with propriety be composed of the more delicate orders, and be adorned in the highest degree.

The gates of parks and gardens are commonly shut with iron folding grates, either plane or adorned: those of palaces should likewise be so, or else be left open all the day.

Niches. A niche is a recess in a wall, for the purpose of enshrining a statue or some other ornament, or as an ornament to the wall itself. Among the works of the Romans, niches have either that of a circular or rectangular plan: the heads of those which have circular plans are almost always spherical. In the middle of the attic of the piazza of Nerva, at Rome there is a niche, with a rectangular elevation, and a cylindrical back and head: those upon elliptic plans were not much used by the ancients. In Wood's Ruins of Palmyra there are, however, two exhibited, with elliptic heads within the entrance portico of the temple of the Sun; but no plan is shewn. Niches upon rectangular plans have most frequently horizontal heads: there are a few to be found with cylindrical heads: those upon circular and rectangular plans are, for the most part, placed alternately, for the sake of variety. The plans of niches with cylindrical backs should be semicircular, when the thickness of walls will admit of it; and the depth of those upon rectangular plans should be the half of their breadth, or as deep as may be necessary for the statues they are to contain; their heights depend upon the character of the statues, or on the general forms of groups introduced; seldom exceeding twice and a half of their width, nor les than twice. Niches for busts should have nearly the same proportion with regard to one another; their heights, in some cases, may be something more than their breadth. Some niches may be formed with cylindrical backs and spherical heads; some of them may be entirely formed with hemispherical backs; others of spheroidal backs, with the transverse or conjugate axis of the elipsis vertical, as may be most suitable to the character of the thing to be enshrined: those with spheroidal backs may have their horizontal sections all circles of different diameters, and, consequently, their sections through the vertical axes all equal semi-ellipses, similar to each other; or all their horizontal sections may be similar ellipses, and the sections through the vertical axis of the niche will be dissimilar ellipses of equal heights, at least for one half of the niche; but spheroidal niches with such sections are difficult to execute, and not so agreeable to the eye as those with circular horizontal sections. Niches for busts may be of any of these last forms, or of any other form used by the ancients.

Niches are susceptible of the same decorations as windows; and whether their heads be horizontal, cylindrical, or spherical, the inclosure may be rectangular. In the ruined edifices of antiquity, tabernacles are a very frequent ornament, and these often disposed with triangular and arched pediments alternately: the character of the architecture should be the same as that which is to be placed in the same range with them. Niches are sometimes disposed between columns and pilasters, and sometimes ranged alternately in the same levels with windows; in either case they should be ornamented or plain, as the space will admit.

If the intervals between the columns or pilasters be very narrow, the niches will be much better omitted, than to make them either diminutive, or of a disproportionate figure. When they are ranged with windows, their dimensions should be the same as the aperture of the windows. Niches being intended as repositories for statues, vases, or other works of sculpture, must be contrived to set off the things they are to contain to the best

advantage, and therefore no ornaments whatever should be introduced: the body and head of the niche being as plain as possible, every kind of ornament, whether mouldings or sculpture, tends to confuse the outline.

Statues. Besides decorations of mouldings, columns, and pilasters, architecture is indebted to sculpture for a great part of its magnificence; and as the human body is justly esteemed the most perfect original, it has been customary, in every period, to enrich different parts of buildings with representations thereof. Thus the ancients adorned their temples, basilicos, baths, theatres, and other public structures, with statues of their deities, philosophers, heroes, orators, and legislators; and the moderns still preserve the same custom, placing in their churches, palaces, houses, squares, gardens, and public walks, the busts and statues of illustrious personages; or bas reliefs and groups, composed of various figures, representing memorable occurrences, collected from the histories, fables, or traditions of particular times. Sometimes the statues or groups are detached, and raised on pedestals, and placed contiguous to the walls of buildings, by flights of steps or stairs, at the angles of terraces in the middle of rooms, or of courts, and public squares, but most frequently they are placed in niches. The size of the statue depends upon the dimensions of the niche: it should neither be so large as to seem crammed into it, nor so small as to be lost in it. The distance, between the outline of the statue and the sides of the niche, should never be less than one-third of a head, nor more than the half, whether the niche be square or arched; and when it is a square, the distance from the top of the head to the soffit of the niche should not exceed the distance left on the sides. The statues are generally raised on a plinth, the height of which may be from one-third to one-half of the head; and sometimes, where the niches are very large, in proportion to the architecture they accompany, as may be the case where an order comprehends but one story. The statues may be raised on small pedestals to a proper height, and by this means the figure will not only have a better proportion to the niche but also to the order, to which it would otherwise appear too trifling. Statues are not only placed in niches, but they are also placed on the tops of walls, and before the dwarf pilasters of attics, as in the arch of Constantine, and the Corinthian colonade at Thessalonica.

If there are two rows of niches in the same building, care must be taken to keep the statues of their proper attitudes. The character of the statue should always correspond to the architecture with which it is surrounded. Thus, if the order be Doric, Jupiter, Hercules, Pluto, Neptune, Mars, Esculapius, or any male figures, representing beings of a robust and grave nature, may be introduced. If Ionic, then Apollo, Bacchus, Ceres, Minerva, Mercury: and if Corinthian, Venus and the Graces, Flora, or others of a delicate kind and slender make, may very properly have place.

Proportions of rooms. The proportions of rooms depend much on their use and dimensions; but with regard to the beauty, all figures, from the square to a sesquilateral, may be employed: some have even extended the length of the plan to double its breadth, but this disparity of dimensions renders it impossible to proportion the height to both length and breadth, though galleries are frequently three, four, or even five squares in length; but as the eye only takes in a portion of this length, the comparison is merely made in respect of the breadth. The height of rooms depends upon the dimensions of their plans and the form of the ceilings. In rooms with flat ceilings, if their plan be a square, their height may be from two-thirds to five-sixths of the side; and if an oblong, it may be equal to the width. In covered rooms, if the plan be a square, the height may be equal to the side; if oblong, it may be equal to the breadth only; or with a fifth, a quarter, or a third, of the difference of the length and breadth. In galleries, the height may be from one and a-third to one and three-fifths of the breadth. These are the general relative dimensions of rooms; but good proportions are not always attainable, particularly in houses of great magnitude; since the same common height is that of all the rooms, whatever be the difference of their plans with regard to their size; however, to keep the best possible proportions, the principal rooms may have flat ceilings, and the middle-sized ones may be reduced by coving the ceilings with a flat in the middle; or by groins, or domes, as may answer their heights: but if the loftiest of these coved figures leaves still too great a height, recourse must be had to mezzanines; which are not only necessary for this purpose, but may always be employed with advantage, as they afford servant's lodgings, baths, powdering-rooms, wardrobes, and other conveniences. All

rooms of inferior classes may have mezzanines or intersoles.

In buildings, where beauty and magnificence are preferred to economy, the halls and galleries may be raised, making them occupy two stories. Saloons are frequently raised three stories, or the whole height of the building, and have galleries around their interior at the height of the floors, for communicating with the various parts of the building.

When rooms are adorned with an entire order, the entablature may occupy in height from one-sixth to one-seventh of that of the room; if the entablature be without columns, it may have from one-seventh to one-eighth. If a cornice, frize, and astragal, are executed, its height may be equal to a tenth; and if only a cornice, its height may be from a twentieth to a thirtieth part of that of the room. In general, all interior proportions and decorations must be less, and more delicate than those of the exterior. Architraves, in most cases, should not be above one-seventh of the width.

Ceilings. The figures of ceilings are either flat or coved; coved ceilings either have a concavity around the margins, and are flat in the middle, or have a vaulted surface. (See VAULTS). Ceilings, that are coved and flat, may occupy from one-fifth to a fourth part of the height of the room: the principal sections of vaulted ceilings may be of various segments, equal to, or less than semicircles, as may be most suitable to the height of the room. Flat ceilings are adorned with large compartments, or foliages, and other ornaments, or with both. Compartment ceilings are either formed by raising mouldings on the surface, or by depressing the pannels within the moulded inclosure, which may be partly raised upon, and partly recessed within the framing or entirely recessed: the figures of the pannels may either be polygonal, circular, or elliptical. The ceilings of the porticos and of the interior of ancient temples are comparted, and the pannels deeply recessed; the prominent parts between them representing the ancient manner of framing the beams of wood which composed the floors; the mouldings on the sides of the pannels are sunk, by one, two, or several degrees, like inverted steps, and the bottoms of pannels are most frequently decorated with roses; the figures of these compartments are mostly equilateral, and equiangular. Triangles were seldom used, but we find squares, hexagons, and octagons, in great abundance. The framing around the pannels in Roman antiquity is constantly parallel, or of equal breadth, therefore, when squares are introduced, there is no other variety; but hexagons will join in contiguity with one another, or form the interstices into lozenges, or equilateral triangles. Octagons naturally form two varieties, *viz.* that of their own figure, and squares in the interstices: this kind of compartment is called coffering, and the recessed parts coffers, which are used not only in plain ceilings, but also in cylindrical vaults. The borders of the coffering are generally terminated with belts, charged most frequently with foliage; and sometimes again the foliage is bordered with guillochis, as in the temple of Peace at Rome. In the ceiling of the entire temple at Balbec, coffers are disposed around the cylindrical vault, in one row rising over each intercolumn; and between every row of coffers is a projecting belt, ornamented with a guillochi, corresponding with two semi-attached columns in the same vertical plane, one column supporting each springing of the belt. The moderns also follow the same practice in their cupolas and cradle vaults, ornamenting them with coffers and belts: the belts are ornamented with frets, guillochis, or foliages; small pannels are ornamented with roses, and large ones with foliage, or historical subjects, in a variety of different manners.

The grounds may be gilt and the ornaments white, partly coloured, or streaked with gold; or the ornaments may be gilt and the grounds white, pearl, straw-colour, light-blue, or any tint that may agree best with the ornaments. Some ceilings are painted either wholly, or in various compartments only: when a ceiling is painted in representation of a sky, it ought either to be upon a plane or spheric surface. A ceiling coved and flat, with the plane painted to represent the sky, is extremely improper, as the cove represents the half of an arch upon every side of the room, it will seem as if falling, from the want of an apparent support in the middle, unless the ceiling rise from a circular plan. Ceilings coved and flat are much employed in modern apartments: they seem to be a kind of medium between the horizontal and the various arched forms practised by the ancients: they do not require so much height as the latter, but they are neither so graceful nor so grand. Vaulted ceilings are more expensive than plane ones, but they are also susceptible of a greater variety of embellishments.

Chimnies. A chimney is an opening

through a wall upwards, beginning at one side of a room, and ending at the top of a wall: its use is to warm the room, and give passage to the smoke. That part of the opening which faces the room is the place where the fire is put, and consequently is called the fire place: the tube or hollow proceeding from the fire-place upwards, for giving vent to smoke, is called the funnel, or flue: the stone or marble laid level with the floor immediately before the fire-place is called the hearth or slab; and the one under the fire-place the back or inside hearth. The projecting parts of the walls on each side of the fire-place, forming also parts of the surface of the room, and standing at the extremities of the hearth, are called jambs: the head of the fire-place in the surface of a room, resting upon the jambs, is called the mantle: the mantle, and that part of the chimney resting upon it, forming a part of the side of the room, and also the whole side of the flue to the top, is called the breast; the side of the flue opposite to the breast is called the back; and the sides of the fire-place contained between the jambs and the back are called covings. When there are two or more chimnies in the same wall, the flues of which approach very near to each other, the thin division which separates one flue from another is either called a partition, or a with; that part of the opening or horizontal section opposite to the mantle of a fire-place is called the throat; and that turret above the roof of a house, containing one or more flues, is called the shaft.

In stone walls, the most common dimensions of the sections of flues are from 12 to 13 inches square, for fire-places about $3\frac{1}{2}$ feet wide in front; and those in brick walls 14 inches by 9 inches. The area of the section of the flue should always be proportioned to the area of the fire usually put in the fire-place, that is, nearly equal to the area of the horizontal section of the fire itself, excepting at the throat. The throat should be immediately over the fire, and its horizontal dimensions in the thickness of the wall should not exceed $4\frac{1}{2}$, or 5 inches at most. The fuel grate, or stove, should be brought as near to the throat as conveniency may require. The coving should be placed bevelling nearer together at the back than at the jambs, making an exterior angle with the front of the jambs, and an interior angle with the back, of 135 degrees each. The back and covings forming the sides of the fire-place should be of white materials, such as white stone, or brick covered with plaster, which are most conveniently put up after the house is built. Most metals are unfavourable for this purpose. The top of the throat should be quite level, forming an abrupt plane. Some of the principles in the construction of chimnies are very well ascertained, others are not easily discovered till tried. The more the air that goes into the flue is rarefied, with the more force it will ascend, and the higher the flue the greater also will this force be; therefore the fire should have as little vacancy on either side as possible, and the flue, when convenient, should be carried as high as possible, and not have too wide an aperture at the top. The situation of doors in a room, the grate being placed too low, and other things, often occasion smoke; but whatever be the cause of it, if once discovered the evil may easily be remedied. Circular flues are more favourable for venting than those whose sections are rectangular.

Vaults. A vault is an interior roof over an apartment, rising in a concave direction from the walls which support it, either meeting the vertex in a point or line, as when the section of the arch is Gothic; or one continued arch from the one abutment to the other, as when the section is a semicircle, or a segment less than a semicircle.

The vertical sections of the intradoes of vaults may be formed by an infinite variety of curves; but the most elegant forms are either circular or elliptic; which forms of sections have been generally adopted by the ancients of remote antiquity, by our ancestors throughout the middle ages, and by European nations at the present day. We shall therefore confine ourselves to those vaults which have their extradoes of circular and elliptic sections.

A cylindrical vault is a plain vault, the figure of the extradoes of which is a portion of a cylindric surface, terminating on the top of the walls which support it in a horizontal plane, parallel to the axis of the cylinder. This is also called a cradle vault.

A cylindroidal vault is a plain vault, the figure of the extradoes of which springs from a horizontal plane; its section perpendicular to those lines is every where a semi-ellipsis, equal and similar throughout, and its base is that of either axis; or it is sometimes a segment of an ellipsis, less than a semi-ellipsis, having an ordinate parallel to the axis for its base.

A dome may be defined to be a vault rising from a circular, elliptical, or polygonal plan or base, such that all horizontal sections of the intradoes are similar

figures, having their centres in the same vertical line or axis, and such that the plans of any two sections may have the sides of similar inscribed figures parallel to each other, or that the figures of these plans may be concentric. If the dome is a portion of a sphere, that is, if its base be a circle, and its vertical section through the centre of its base the segment of a circle, then it is also called a cupola.

When the portion of a sphere, or cupola, springs from a wall on a polygonal plan, and the vertical axis of the sphere passes through the middle of the plan, then the spandrels, or triangular spheric portions, comprehended between the springing lines and a horizontal plane passing through the different summits of the walls, are called pendentives.

When two or more plain vaults penetrate or intersect each other, the figure of the intrados formed by the several branches is called a groin, or cross vault.

When two opposite equal branches meet other two opposite equal branches in two intersecting vertical planes, passing through the diagonal lines, joining the four exterior angles of the plane, the groin may be called an equal pitched quadrilateral groin.

If two opposite branches of an equal pitched groin have cylindrical intradoes, and their plan of less breadth than that of the other two branches, the groin may be called cylindro-cylindroidal, or cylindroido cylindric groin, according as the cylindric branches or the other two are of the greatest breadth.

When a groin consisting of four branches is made by two equal portions of cylindric surfaces, with the axis of the one cutting that of the other, it is called an equal pitched cylindric groin.

When two opposite branches of a cylindric groin are of less breadth than the other two, it may be called an unequal pitched cylindric groin. This is called by workmen a Welsh groin.

When the branches of a cylindric groin are of equal breadth in the plan, the groin may be called an equilateral cylindric groin.

It is not easy to give a geometrical definition that will extend to all properties of vaulting, called, by writers of the first eminence, groins. The first given is almost universal. It applies not only to plain vaults intersecting each other, but also to those that are annular, or in the form of semi-cylindric rings, intersected by cylindric or cylindroidal plain vaults, the axis of which tends to that of the annulus. It does not, however, comprehend that species used in King Henry VII's chapel, Westminster, and King's College chapel, Cambridge.

This species of groins, instead of the horizontal sections of the curved surfaces presenting exterior right angles, as is generally the case, present convex arches of circles. There is yet one property that is common to every species of groins, that is, the several branches intersect and form arches upon each inclosing wall, and the perpendicular surface of the wall upon each side is continued till it is intercepted by the intradoes of the arches; consequently the upright of each wall is equal in height to the summit of the arches. Hence the difference between groins and domes. A groin is a branched vault, and each branch terminates against the enclosing walls; whereas a dome is a vault without branches, and the curves spring from the wall, or walls, from all points around its bottom circumference, whether the walls stand upon a polygonal, circular, or elliptic plan.

The Greeks, it would appear, had few or no arches or vaults much prior to the reign of Augustus, from which time they sometimes employed plain vaults with cylindrical intradoes; we also find that they used quadrilateral, equal pitched groined vaults, with cylindrical or cylindroidal intradoes, or mixed of both, over the passages of the theatres and gymnasia.

The Romans, as would appear also, did not empoly vaults more early than the Greeks. The Pantheon, one of the earliest remaining structures with arches, was probably built by Agrippa, the son-in-law of Augustus, though some maintain that he only added the portico; but of this there is no proof, as no mention is made of this celebrated building before his time. We find from Vitruvius (lib. iii. c. 3,) that the floors of temples were frequently supported by vaults, and (lib. v. c. 1,) that the roofs of basilicas were vaulted of the tortoise form, which he distinguishes by the name of testudo. This form of vaulting is very flat, with four curved sides springing from each of the four walls, and it approaches nearly to that of a flat dome upon a rectangular plan.

We also find, from the remains of Roman buildings, the ceilings of their apartments vaulted. The side apartments, or chapels, of the Temple of Peace, and of the baths of Dioclesian, have vaults with cylindrical intradoes, while the great rectangular apartment in each of these edifi-

ces is vaulted in the groined form; and it is remarkable that the groins are not formed by the intradoes of the vaults in the chapels, for the summits of the vaults in these rise but a small distance above the springings of the middle groins. It may also be remarked, that the piers between the chapels have small arcades, the summits of which are considerably below the cylindrical intradoes of the side vaults. This circumstance is not peculiar to these buildings, as is to be found in many others. This is to be seen distinctly in the plates of the Temple of Peace, by Desgodetz. The Romans employed annular vaults, as in the temple of Bacchus; and in this, as in the temple of Peace, and the baths of Dioclesian, the summits of the arcades supporting the cylindric wall and dome of the central apartments do not intersect the annular intradoes, but the convex side of the cylindric wall which supports this annular intrados, and consequently do not form groins. The intradoes of the Roman domes are of a semicircular section, as may be seen in the Pantheon, the temple of Bacchus at Rome, the temple of Jupiter, and vestibule of the palace of Dioclesian, at Spalatro, in Dalmatia, while the vertical section of the extradoes through the axis is a much less segment, as the Pantheon at Rome, and the vestibule and palace of Dioclesian, exhibit. We have no instances among the Roman or Grecian buildings of pendentives or spandrels which are supported by four pillars, or by quadrangular or polygonal walls, and which support themselves on a spheric dome or cylindrical wall. Pendentives rising from four pillars, and a dome from the top of the pendentives, were first put in practice, it is said, in the celebrated church of Sancta Sophia at Constantinople.

In the rectangular buildings of the middle ages, quadrangular, equal pitched groins were generally used; and in circular buildings we have annular groins, as in the Church of the Holy Sepulchre at Cambridge, and Temple Church, London. We have also mentioned those curious groins which are exhibited in the ceilings of King's College Chapel, Cambridge; St. George's Chapel, Windsor; and King Henry the Seventh's Chapel, Westminster, of modern invention.

In the present day, every species of vaulting, that were either used by the ancients or throughout the middle ages, are employed, both for the sake of variety, and for elegance.

It does not appear that the ancients were acquainted with cylindrical, unequal pitched groins, at least by way of ornament; this form is, however, very beautiful, as the arcades above the passage through the front of Somerset-House clearly exhibit.

ARCHYTAS, of Tarentum, in biography, a celebrated mathematician, cosmographer, and Pythagorean philosopher, of whom Horace says,

———*Maris ac terræ, numeroque carentis arenæ*
Mensorem cohibent, Archyta, &c.

He flourished about four hundred years before Christ, and was the master of Plato, Eudoxus, and Philolaus. He gave a method of finding two mean proportionals between two given lines, and thence the duplication of the cube, by means of the conic sections. His skill in mechanics was such, that he was said to be the inventor of the crane and the screw; and he made a wooden pigeon that could fly about, when it was once set off; but it could not rise again of itself, after it rested. He wrote several works, though none of them are now extant, particularly a treatise Περι τȣ Παντος, *De Universo*, cited by Simplicius in Arist. Categ. It is said he invented the ten categories. He acquired great reputation both in his legislative and military capacity; having commanded an army seven times without ever being defeated. He was at last shipwrecked, and drowned in the Adriatic sea.

Archytas was distinguished through life by modesty and self-command. He maintained, that virtue was to be pursued for its own sake in every condition of life; that all excess is inconsistent with virtue; that the mind is more injured by prosperity than by adversity; that there is no pestilence so pernicious to human happiness as pleasure; and that the love of it is a disease destructive to the human mind.

ARCTIC, in astronomy, an epithet given to the north pole, and likewise to a circle of the sphere parallel to the equator, and 23 degrees 30 minutes distant from the north pole.

ARCTIUM, the *burdock*, in botany, a genus of the Syngenesia Polygamia Equalis class of plants; the common calyx of which is globose and imbricated; the compound flower is tubulated and uniform, with equal hermaphrodite corollulæ: the proper flower is monopetalous and tubulous, with a slender and very long

tube; there is no pericarpium; the cup is connivent and the seed single, vertically pyramidical, and crowned with a simple down, shorter than the seed. There are two species; *viz.* the Laffa and Bardana.

ARCTOMYS, the *marmot*, in natural history, a genus of the Mammalia class of animals, of which the generic character is, front teeth two in each jaw, strong, sharp, and cuneated; grinders in the upper jaw, five on each side, in the lower jaw four; clavicles or collar bones perfect. This genus differs but little from the Mus tribe, so that naturalists have sometimes doubted whether they should be separated into distinct genera. They are diurnal animals; feed on roots, grain, and fruits, which they often collect in heaps. They reside in subterraneous holes, and become torpid in the winter. The head is gibbous, or rounded, with short ears, or none; body thick; tail short; hairy; fore feet four-toed, with a very short thumb; hind feet five-toed; cœcum large. There are eleven species, of which we shall notice the following: 1. Arctomys marmota, or Alpine marmot: ears short, round; body brown, beneath reddish. It inhabits dry open places, on the summits of the Alps and Pyrenees; feeds naturally on roots, herbs, and insects; when tamed it will eat any thing that is offered; drinks little; basks in the sun; lives among small tribes, with a centinel placed, to give notice of danger, which is done with a hiss; forms a burrow, with many chambers and entrances, for the summer; another lined with soft grass, in which it remains torpid during winter; it eats with its fore paws; walks on its heels, often erect; is easily caught when out of its burrow; in a tame state very destructive of food, cloaths, and furniture; hardly kept awake in winter, even in warm chambers; gravid seven weeks, and brings from two to four at a time. These animals make no provision for the winter, but as soon as the frosts set in they carefully stop up the entrances to their mansions, and gradually fall into a state of torpidity, in which they continue till the beginning of spring, when they awake and commence their excursions. Before they retire to winter quarters they grow excessively fat, and appear very emaciated on first emerging from them. If carefully dug up during the winter, they may be conveyed away in their sleeping state, and when brought into a warm chamber gradually awaken.

A. Empetra, or Quebec marmot, is rather larger than a rabbit, with short ears and a round head. It inhabits Hudson's Bay and Canada. A. monax, or ground-hog, is found in various parts of North America, and in its habits and manners is very like that already noticed. The marmot, when taken young, may be easily domesticated, and taught to perform various gesticulations, such as holding a stick, dancing, &c. See Plate II. Mammalia, in which will be seen the hamster and lemming, sometimes called the Lapland marmot; descriptions of these will be found in the article Mus. A bobac, or grey marmot, is a native of the high, but milder and sunny sides of mountainous countries, which abound with free-stone rocks, where it is found in dry situations. It frequents Poland and Russia, among the Carpathian hills: it swarms in the Ukraine, about the Boristhenes, and between this river and the Don, and along the range of hills which extend to the Wolga. It is found about the Yaik, and inhabits the southern desert in Great Tartary. It is not to be seen in Siberia, on account of its northern situation, and rarely reaches in Kamschatka as high as 55°. The colour is grey above, with the throat, inside of the limbs, and under parts of the body, fulvous or ferruginous; the tail is short, rather slender, and full of hair. Its manner of life resembles the Alpine marmot. The holes of these animals are lined with the finest hay, and in such quantities, that, it is said, enough has been found in a single receptacle to feed a horse for a night. A. citillus, or variegated marmot, is the most beautiful of all the species: in size it differs very much: some are as large as the Alpine marmot, and others not larger than a common water rat. The variegated marmot inhabits Bohemia and other parts of Germany, from the banks of the Wolga to India and Persia, through Siberia and Great Tartary to Kamschatka, and even the continent of America. It is not certain that these sleep in the winter like others of the Arctomys genus. They breed in the spring, and produce from five to eight at a time. They are said to be irascible and quarrelsome among themselves, and their bite is very severe. They feed not only on animal food, but on small birds and other animals, which they will kill. They are easily tamed, and will grow familiar in a few days. They are extremely clean, and after feeding generally wash their faces, and clean their fur. Like other domestic animals, they are fond of being caressed, and will feed from the hand. Their sleep is profound

during the whole night, and in cold and rainy weather through the greater part of the day. See Plate II. Mammalia, fig. 1, 2, and 5.

ARCTOPUS, in botany, a genus of the Polygamia Dioecia class of plants, the general umbel of which is long and unequal; the partial umbel is shorter; the involucra consists of five leaves; the corolla of five petals; the fruit is single and bilocular, and stands under the receptacle of the floscule; the seed is single, cordated, and accuminated. There is but one species.

ARCTOTHECA, in botany, a genus of the Syngenesia Necessaria; receptacle cellular and chaffy; calyx imbricate. There is but one species.

ARCTOTIS, in botany, a genus of the Syngenesia Necessaria class of plants, the common calyx of which is roundish and imbricated; the compound flower is radiated; the hermaphrodite corollulæ are tubulous and numerous in the disk: the proper hermaphrodite flowers are funnel-shaped; there is no pericarpium; the seed is single, roundish and hairy. This genus is separated into the following divisions: A. receptacle villous, 31 species; B. receptacle chaffy, 11 species; C. doubtful, 18 species.

ARCTURUS, a fixed star of the first magnitude, in the skirt of Boötes, so called from the circumstance of its being near the tail of the Bear. It has been thought to be the nearest fixed star to our system visible in the northern hemisphere, because the variation of its place, in consequence of a proper motion of its own, is more remarkable than that of any other of the stars; and by comparing a variety of observations respecting the quantity and direction of the motion of this star, he infers, that the obliquity of the ecliptic decreases at the rate of 58″ in 100 years, a quantity that nearly corresponds to the mean of the computations framed by the celebrated Euler and Lalande upon the more unerring principles of attraction.

ARCTUS, in astronomy, the Greek name for the Ursa Major and Minor.

ARDEA, in natural history, a genus of birds of the order of Grallæ. The characters of this genus are, a long, strong, sharp-pointed bill; nostrils linear; tongue pointed; toes connected by a membrane as far as the first joint; the middle claw of some of the species, of which there are 79, pectinated. This genus is separated into five divisions, *viz.* A. crested; bill hardly longer than the head; B. cranes, bald; C. storks, orbits naked; D. herons, middle claw serrate inwardly; E. bill gaping in the middle.

Some ornithologists have separated the herons from the storks and cranes; others, preferring the Linnæan system, class the whole under one genus, which, according to Gmelin, consists of nearly 100 species, though Latham enumerated but 79. They are widely distributed over various parts of the globe, differing in size, figure, and plumage, and with talons adapted to their various places of residence, or their peculiar pursuits. But, notwithstanding the variety in their bills and plumage, the manners of all are nearly the same, so also is their character, which is stigmatized with cowardice and rapacity, indolence, and yet insatiable hunger; and it has been observed, that, from the meagre-looking form of their bodies, one would suppose the greatest abundance almost insufficient for their support.

Ardea pavonia. This is as large as the common heron; the length two feet nine inches; the bill is two inches and a half long, straight, and of a brownish colour; irides grey; the crown of the head covered with soft black feathers like velvet; on the hind part is a tuft composed of hair, or rather bristles, arising near each other at the base, and spreading out on all sides in a globular form; this is four inches in length, and of a reddish brown colour; the sides of the head are bare of feathers, being covered only by a fleshy membrane of a reddish colour at the lower part, and in shape not unlike a kidney; on each side of the throat hangs a kind of wattle; the general colour of the bird bluish-ash; the feathers on the fore part of the neck are very long, and hang over the breast; wing coverts white; the greater ones incline to rufous, and those farthest from the body to black; the greater quills and tail are black, and the secondaries chesnuts; the legs and the bare part above the knee are dusky. The female is black where the male is blue-ash; and the wattles on the throat are wanting; the long feathers on the breast are also less conspicuous. This beautiful species is an inhabitant of Africa, particularly the coast of Guinea, as far as Cape Verd; at this last place they are said to be wonderfully tame, and will often come into the court-yards to feed with the poultry. Why the name of Balearic crane has been given to this bird is not well ascertained, as it is certainly not met with in the Balearic Islands at this day. These birds are often kept in our menageries, and with shelter at night often live a good while. Their

chief food is supposed to be worms, and such other things as the herontribe usually feed on; also vegetables of all kinds. It often sleeps on one leg, runs very fast, and is said not only to fly well, but to sustain it for a long time together. The flesh of this bird is said to be very tough.

Ardea virgo, or the Numidian crane. Size of the crane; length three feet three inches: the bill straight, two inches and a half long, greenish at the base, then yellowish, with the tip red; irides crimson. The crown of the head is ash-colour; the rest of the head, the upper part of the neck behind, and all the under parts to the breast, black; on the last, the feathers are long and hang downwards; the back, rump, and tail, and all the under part from the breast, are of a bluish ash-colour; behind each eye springs a tuft of long white feathers, which decline downwards, and hang in an elegant manner; the quills and tail are black at the ends; the legs are black. This species is found in many parts of Africa and Asia. In the first it has been met with on the coast of Guinea; but is most plentiful about Bildulgerid, (the ancient Numidia), and Tripoli; from thence along the coasts of the Mediterranean Sea, and pretty common in Egypt. They are also at Aleppo, and in the southern plain about the Black and Caspian Seas; and are seen frequently beyond Lake Baikal, about the rivers Selenga and Argun, but never venture to the northward. In all places they prefer marshes and the neighbourhood of rivers, as their food is fish, like most of the heron genus. It is frequently kept in menageries, being endowed with great gentleness of manners, added to its being an elegant bird. At various times it puts itself into strange and uncouth attitudes, and especially those which imitate dancing: and Keysler mentions one in the Great Duke's Gallery at Florence, which had been taught to dance to a certain tune when played or sung to it. The name this bird is known by in the east is Kurki, or Querky. See Plate II. Aves, fig. 7.

Ardea grus. This is a large bird, not unfrequently weighing ten pounds, and measures more than five feet in length. This species seems far spread, being met with in great flocks throughout northern Europe and Asia, in Sweden, Russia throughout, and Siberia as far as the river Anadyr, migrating even to the Arctic Circle. In Kamtschatka only seen on the southern promontory; are migratory, returning northward to breed in the spring, and generally choosing the same places which had been occupied by them the season before. In the winter they inhabit the warmer regions, such as Egypt, Aleppo, India, &c. they are also met with at the Cape of Good Hope, changing place with the season. In their migrations frequently fly so high as not to be visible, their passage only being known by the noise they make, being louder than that of any other bird. In France they are seen in spring and autumn; but for the most part are mere passengers. We are told that they frequented the marshes of Loncolnshire and Cambridgeshire, in vast flocks, formerly; but the case is altered, as of late none have been met with, except, a few years since, a single bird shot near Cambridge. We are told that they make their nests in marshes, and lay two bluish eggs. The young birds are thought very good food. They feed on reptiles of all kinds, and in turn on green corn; of which last they are said to make so great havock, as to ruin the farmers wherever the flocks of these depredators alight.

Ardea ciconia, or white stork, is the size of a turkey, inhabits in turns the various parts of the old continent, avoiding alike the extremes of heat and cold, being never met with between the tropics, nor scarcely ever seen more north than Sweden, or in Russia beyond 50°. It never frequents Siberia, though it is sometimes found in Bucharia, where it makes its nest, tending towards the south in autumn, to winter in Egypt. It is rarely met with in England, though well known in France and Holland. They every where build on the tops of houses, and the good natured inhabitants provide boxes for them to make their nests in; they not only do this, but are particularly careful that the birds suffer no injury, resenting it as done to themselves. At Bagdad they are to be seen on every house, wall, and tree, quite tame. At Persepolis the remains of the pillars serve them to build on, every pillar having a nest. They are thought to have two broods in a year, the first towards the north, the latter in warmer places; and are seen in vast flocks during their migrations. The female makes a large nest, and lays from two to four eggs. The young are hatched in a month; the male and female watch them by turns till they can provide for themselves. The stork sleeps on one leg, and snaps with its bill in a singular manner. Its food consists in snakes and other reptiles; hence the veneration of all persons for this bird, which frees them from such pests.

Ardea stellaris, or bittern. This is an elegant species, and is somewhat less than the heron; length two feet six inches; the bill brown, beneath inclining to green; irides yellow; the head feathers are long, and those of the neck loose and waving; the crown of the head black; the lower jaw on each side dusky; the plumage in general is beautifully variegated; the ground a ferruginous yellow, palest beneath, marked with numerous bars, streaks, and zigzag lines of black; the legs are pale green; claws long and slender; and the inner edge on the middle claw serrated. The female is less, darker coloured, and the feathers on the head and neck less flowing than in the male. This is a common bird, we believe, in most of the temperate parts of the continent of Europe; in some of the colder, migratory; with us it remains the whole year; frequents marshy places, and especially where reeds grow, among which it makes its nest, in April, which is chiefly composed of a bed of rushes, &c. The female lays four or five eggs, of a pale greenish ash colour; the young are hatched in twenty-five days. It is an indolent bird, stirring very little in the day unless disturbed; though if once roused is not difficult to shoot, as it flies heavily. In the evening, after sun-set, it is seen to soar aloft in a spiral ascent, till quite out of sight, and this chiefly in autumn, making a singular kind of noise; it has also another noise, like that of a bellowing bull, beginning in February, and ceasing after breeding-time; but this is done while on the ground. If attacked by dogs or men, it defends itself well; and is said to strike at the eyes of the enemy. The food is frogs, mice, and other reptiles, which it swallows whole, as well as fish. Latham remembers to have found two middle-sized trouts in the stomach of one, perfectly whole. It is reckoned pretty good eating. See Plate III. Aves, fig. 7. and Plate IV. fig. 1.

ARDISIA, in botany, a genus of the Pentandria Monogynia class and order. Calyx five-leaved; corol. salver-shaped, with the border reflected; antheræ large, erect; stigma simple; drupe superior; one-seeded. There are nine species.

ARDUINA, in botany, a genus of the Pentandria Monogynia class and order. Corol. one-petalled; stigma bifid; berry two-celled; seeds solitary; a shrub of the Cape of Good Hope.

ARE, in French measure, is a superficial unit, or a square, the side of which is 100 metres in length, or 10,000 square metres; the rectilineal metre being 3.281 feet, the are will be 1076.49 square feet. The tenth of an are, called deciare, is a superficies 100 metres long, and 10 broad; or 1000 square metres = 1076.49; and the centiare equal to 100 square metres, is 1076.49 square feet. See MEASURE.

AREA, in geometry, denotes the superficial content of any figure; thus, if we suppose a parallelogram six inches long, and four broad, its area will be $6 \times 4 = 24$ square inches.

ARECA, in botany, a genus of plants, the characters of which are not perfectly ascertained; the calyx of the male flower is a bivalve spatha, the spadix is ramose; the corolla consists of three acuminated petals; the stamina are nine filaments, of which the three exterior ones are the longest; the female flowers are in the same spadix and spatha; the corolla is like the male corolla; the fruit is a suboval fibrose drupe, surrounded at the base with an imbricated calyx, and containing an oval seed.

There are three species, of which the oryzæformis is the cabbage-tree of the East Indies. The oleracea is found in the West Indies, the green tops of which are cut and eaten as a cabbage.

ARENARIA, *sand-wort*, in botany, a genus of the Decandria Trigynia. Calyx five-leaved, spreading; petals five, entire; capsule superior, one-celled, many-seeded. There are 36 species.

ARENARIUS, the name of a book of Archimedes, in which is demonstrated, that not only the sands of the earth, but even a greater quantity of particles than could be obtained in the immense sphere of the fixed stars, might be expressed by numbers, in a way invented and described by himself.

AREOMETER, an instrument by which the density and gravity of fluids are measured. The invention of this instrument is ascribed to Hypatia, the daughter of Theo, in the fourth century. It is usually made of glass, consisting of a round hollow ball, which terminates in a long slender neck, hermetically sealed at top, there being first as much running mercury put into it as will serve to balance, or keep it in an erect position. The neck or stem is divided into degrees, and by the depth of its descent into any liquor the lightness of that liquor is estimated, for the fluid in which it sinks least is the heaviest; and that in which it sinks lowest is lightest. See HYDROMETER.

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